ANALYSIS OF A WORKLOAD CONTROL DOCUMENTATION SYSTEM

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NAVAL POSTGRADUATE SCHOOL
Monterey, California

THESIS

ANALYSIS OF A WORKLOAD CONTROL
DOCUMENTATION SYSTEM

by

Leslie Glenn Murray

March 1975

Thesis Advisor: S.H. Parry

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UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) ANALYSIS OF A WORKLOAD CONTROL DOCUMENTATION SYSTEM		5. TYPE OF REPORT & PERIOD COVERED Master Thesis; March 1975
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Leslie Glenn Murray		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Naval Postgraduate School Monterey, California 93940		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS Naval Postgraduate School Monterey, California 93940		12. REPORT DATE March 1975
		13. NUMBER OF PAGES 90
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office) Naval Postgraduate School Monterey, California 93940		15. SECURITY CLASS. (of this report) Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A study of the Master Data Record system used at the Naval Air Rework Facility, North Island, California, was undertaken. Several visits were made to the facility and personnel were interviewed. An operational knowledge of the Master Data Record file maintenance procedure was gained and several problem areas were explored. A proposed On-Line Master Data Record Project being pursued at the facility was studied and critiqued.

Several alternative solutions to the problems existing in the present file maintenance system and recommendations for further study were made.

Analysis of a Workload Control Documentation System

by

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Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN MANAGEMENT

from the

NAVAL POSTGRADUATE SCHOOL
March 1975

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A study of the Master Data Record system used at the Naval Air Rework Facility, North Island, California, was undertaken. Several visits were made to the facility and personnel were interviewed. An operational knowledge of the Master Data Record file maintenance procedure was gained and several problem areas were explored. A proposed On-Line Master Data Record Project being pursued at the facility was studied and critiqued. Several alternative solutions to the problem existing in the present file maintenance system and recommendations for further study were made.

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ACKNOWLEDGEMENT

The data supporting the material presented in this thesis was gathered through observations and personal interviews with the management and personnel of the Naval Air Rework Facility, North Island. The author was allowed free access and choice into areas investigated and received thoughtful and courteous cooperation from all personnel contacted. The author wishes to thank Mr. Robert Urban and Mr. Joe Liermann for their time and support. A special thanks goes to Mr. Ray Pathman who freely gave great amounts of his time and knowledge to the effort. All opinions and recommendations expressed in this thesis are those of the author.

I. INTRODUCTION

A. NAVAL AIR REWORK FACILITY, NORTH ISLAND

The Naval Air Rework Facility (NAVAIREWORKFAC), North Island Naval Air Station, San Diego, California, is the largest of six naval air rework facilities presently operated by the United States Navy, to service aircraft of the United States Navy and Marine Corps. The facility is an industrial activity of the naval shore establishment, under the command and primary support of the Commander, Naval Air Systems Command. Command, management coordination and technical control has been delegated to the Assistant Commander for Logistics/Fleet Support, Naval Air Systems Command, who exercises this responsibility through the NAVAIRSYSCOMREPAC. The Commanding Officer, NAVAIREWORKFAC, is held accountable for the efficiency, effectiveness of performance, and economy of operations and prescribes vital management systems and standards within which local management structure and systems will be developed. The NAVAIREWORKFAC is under Navy Industrial Funding.

The workload of the NAVAIREWORKFAC includes a complete range of rework and engineering operations on designated weapons such as aircraft, engines, components and associated accessories and equipments. Aircraft serviced by the NAVAIREWORKFAC include the F-4, E-2 and helicopters. The rework performed on these aircraft includes repair, overhaul,

conversion, modernization, progressive aircraft rework and analytical rework as well as repair of crash damage when feasible. In addition, the NAVAIREWORKFAC, North Island, has been tasked with Project Bee-Line--the conversion of F-4B's to F-4N's.

The NAVAIREWORKFAC is presently made up nine major divisions (Figure 1), and employs over 7,000 personnel. Each division is made up of a direct labor force and an indirect labor force which is composed on managerial, secretarial, supervisory and administrative personnel. The NAVAIREWORKFAC has an annual budget of $165 million and overhauls approximately 80 aircraft and 23,000 related components per quarter.

The Production Engineering Department, 60000, (Figure 2), as one of the staff elements of the NAVAIREWORKFAC, provides functions that are essential to the operations of the other departments of the Activity. The timely execution of these functions require close relationships within the Production Engineering Department as well as with the Production Planning and Control and Aeronautical Engineering Departments. The Production Engineering Department acts upon current and short-range planned production information from the Production Planning and Control Department and longer-range planned production information from the Naval Air Systems Command.

The Operations Analysis Division, 62000, initiates the production engineering of these programs, and develops

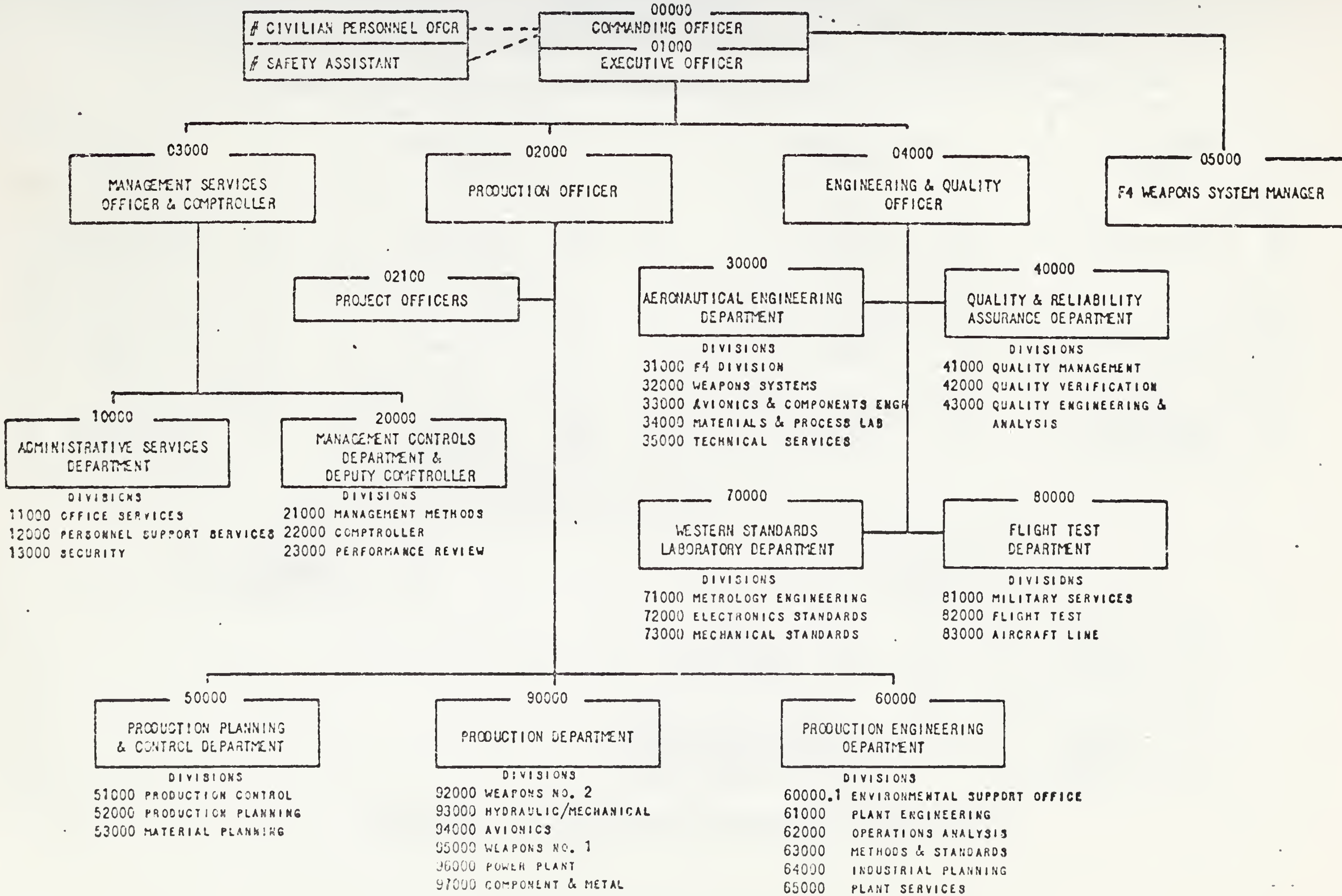


Figure 1. NAVAIREWORKFAC Organization Chart

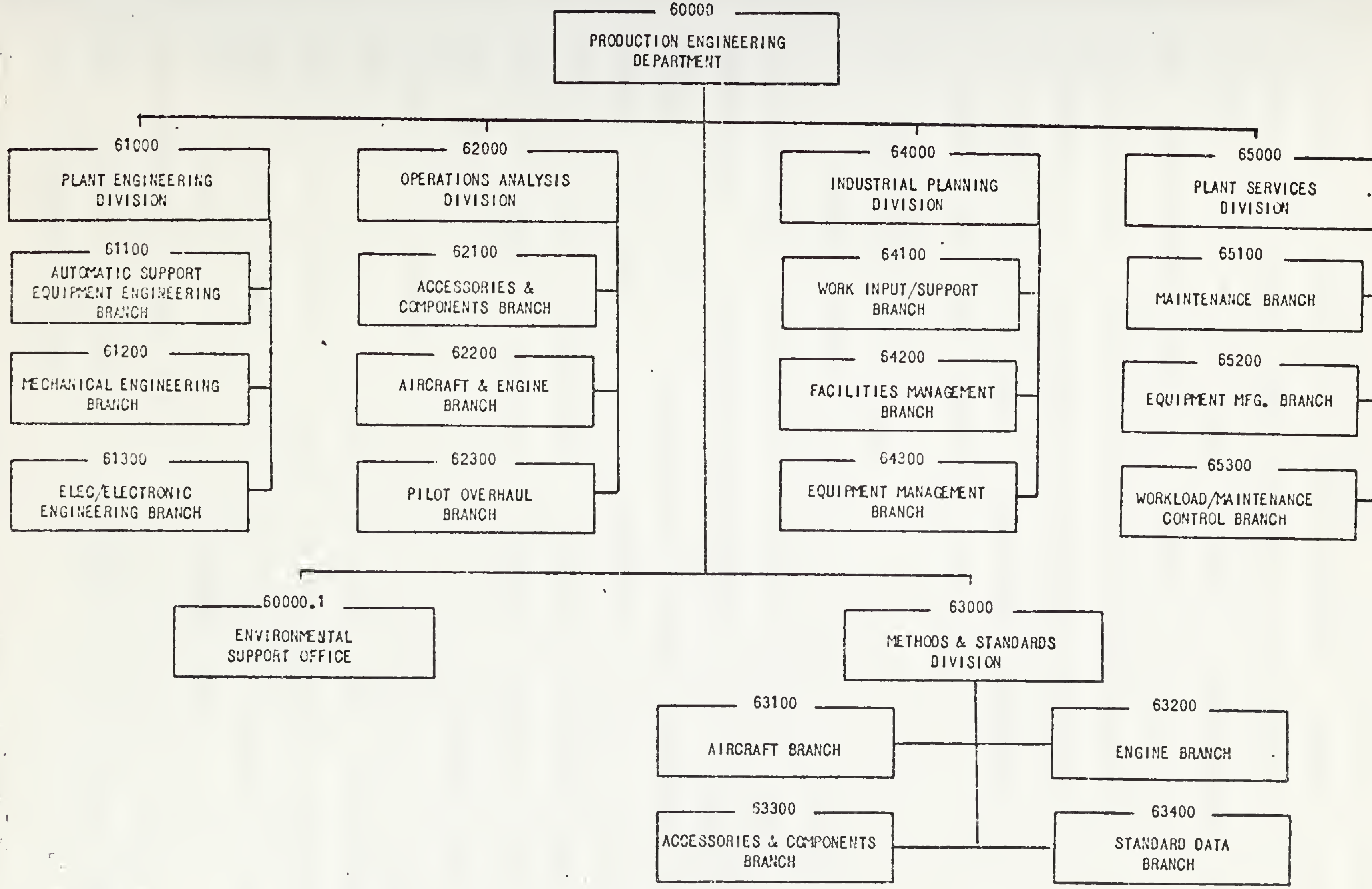


Figure 2. Production Engineering Department

and implements the operations analysis program covering the production shop operations. The Operations Analysis Division is composed of three branches: Accessories and Components Branch, 62100; Aircraft and Engines Branch, 62200; Pilot Overhaul Branch, 62300. The data furnished by the Operations Analysis (62000) and by the Methods and Standards (63000) Divisions are the basic tools for the Production Planning and Production Control Divisions of the Production Planning and Control Department in carrying out their respective functions.

B. DEFINITION OF PROBLEM

An orderly induction and flow of work through the NAVAIREWORKFAC is assured by detailed Workload Control procedures. A management information system, NAILC/MIS Stage I, provides information retrieval to the operational level. That portion of the NAILC/MIS which is the responsibility of the NAVAIREWORKFAC is known as the Workload Control Segment. The Workload Control Segment provides the means to retrieve information from the production shops and to process the data with certain source documents to create required management reports. The various master data files required to support this management information systems are primarily maintained by the Operational Analysis Division. The Operations Analysis Division also researches and develops the technical data for the preparation and maintenance of the Master Data Records (MDR) on all rework programs.

The MDR is the primary source of data for the preparation of production control documentation and subsequent management reports. The MDR file must be created and maintained properly before any of the other NAILC/MIS applications can be successfully operational. The MDR is a dynamic Master File which requires timely and accurate file maintenance to insure that production control and management reports contain the latest information.

The NAVAIREWORKFAC has a master data file of approximately 159,000 MDRs as of the end of 1974. These MDRs are the responsibility of the three branches of the Operations Analysis Division with the Components Branch, 62100, responsible for approximately 75 percent of the existing MDRs. The daily MDR file maintenance required is becoming an increasingly greater part of the Operations Analysis Division's workload. The Components Branch also has the responsibility of routing other branch MDR inputs and maintains the Optical Character Recognization (OCR) typist pool for the division (with the exception of two OCR typists in the 62200 Branch). The daily file maintenance consists of update actions resulting from changes to time standards, codes, processes, routings, technical directives, deletion of MDRs for components no longer processed and the addition of new MDRs.

The master data file is on magnetic tape storage in a computer, but the file maintenance is accomplished by manual means such as hand-written forms, the guard

mail and OCR typists to produce an OCR input to be read by an OCR scanner. The OCR scanner transfers the MDR update information to magnetic tape for batch updating the master data file at a later time. Essentially, the present manual file maintenance process results in time delays which average five to seven days to update an MDR. In addition, priority items, heavier than usual workload for the analysts and OCR typists and human factors frequently produce backlogs which can result in time delays much greater than for routine changes.

C. PURPOSE AND OBJECTIVES

Early in 1973 NAVAIREWORKFAC recognized the problems inherent in the manual maintenance system used for the MDR master file, and a need to upgrade the present method of file maintenance was clearly established. Code 210 was directed to begin a detailed study of the potential for random access (on-line) updating of MDRs via remoted terminals connected directly to a computer. Meetings with Data Processing Services Center Pacific resulted in a proposed on-line system utilizing the Burroughs 4700 computer via remoted CRT terminals and remoted printers. NAVAIREWORKFAC and Code 210 personnel have pursued the project with hopeful implementation of system on 15 September 1974. However, personnel equipment and monetary restraints have precluded meeting the September date. As of January, 1975, a user "Synopsis of System Requirements" has been compiled to be forwarded to the NAILC/MIS MDR

Program Manager as the NAVAIREWORKFAC, NORIS, requirements for On-Line MDR Maintenance. In addition, system specifications are being prepared to forward to the Data Processing Service Center, Pacific, (DPSCPAC) and Workload Control Team; the specifications are expected to be completed by 15 March, 1975.

The purpose of the work presented in this paper is to study the present MDR file maintenance system and report on the system, how it operates and problem areas encountered. Several problems which exist in the present system, along with possible methods for remedying the problems will be described. The MDR On-Line Project presently being pursued by the NAVAIREWORKFAC will be discussed and critiqued, and several recommendations for further study presented.

II. PRESENT MDR FILE MAINTENANCE

A. MASTER DATA RECORD

1. Definition

The MDR is the primary source document for production control documentation and subsequent management reports. At the end of 1974 NAVAIREWORKFAC maintained an MDR Master File composed of approximately 159,000 separate documents. The MDR Master File is stored on magnetic tape in a Univac 3301 computer system; the master file is interfaced with other computer routines of the NAILC/MIS system to produce various reports, some automatically and others on request. A hard copy (shown in Figure 3) of each individual MDR is filed in tub-type bins located in the branch of the Operations Analysis Division responsible for that type of MDR. Accessories and the Components Branch, 62100, has responsibility for approximately 123,000 MDRs; the Aircraft and Engines Branch, 62200, approximately 24,000 MDRs; and the Pilot Overhaul Branch, 62300, approximately 11,000 MDRs.

Four basic types of MDRs are used. The Routing Master Data Record (RMDR) details the routing through the various feeder shops for processing of components. The components may be units removed from an aircraft or engine, inducted for repair and return items through the Component Program, Recall Calibration items, Plant Equipment Calibrated on site, etc. Items removed for

MASTER DATA RECORD

PREVIOUS ISSUES OF THIS FORM ARE OBSOLETE

CONTROL GROUP		PART IDENTIFICATION GROUP									
MDR CONTROL CODE	COMPONENT IDENTITY NO	MDR LOC	S C	INDUCTED FEDERAL STOCK NUMBER	MODIFIED FEDERAL STOCK NUMBER	MODEL CODE	QUANTITY	PROCUREMENT COST	A CODE	REVISION DATE MO DAY YEAR	
0M000	802100000000	101					0001			03-03-74	

	ERROR CODE	MDR LOCATION	MANUFACTURERS PART NUMBER	R D I	N A C	PRODUCT STD	CLASS STD	WORKLOAD STD	DAYS AVAIL	SKD LMT	DISP CODE	NTC CODE	EOY SPRS	AVAIL ABLE	ANALYST CA	COST
E		102	65651-06031-041	1	3				8		BW	5			X9M	000

	MDR LOCATION	PUBLICATION NUMBER	PART NAME	RELATED DESCRIPTION	B CODE
009379	103		VLV-SH-SEQ		

LOAD AND SCHEDULE GROUP

MDR LOC	SHOP NUMBER	GEO AREA	SHOP CAT CODE	OPERATION CODE	OPERATION STANDARD	STD	OCCURRENCE FACTORS S RV	INDUCT	PROD	HAND TIME	NORMAL FLOW TIME	STA FACT	IND FACT	COMP HOUR	SHF LMT	WEIGHTED OPERATION STANDARD	TRADE CODE	MDR LOCATION	OPERATION DESCRIPTION	FACIL CODE	FACILITY STANDARD (HOURS)	OPER STD CATEG
201	93215		WW	C540						00	009	00	09					301				05-2
202	43200		69															302	NO-QCL			05-2
203	43200		69															303	QACC-7			09-2
204			82	GFB1	.30	D												304	C540			09-2
205	92141		81		.20	D												305				12-3
206	97321	L	BP	900A	.10	C				32	001	04	04	09		.10	999	306	CLEAN			08-2
207	93216	L	44	AC11	.20	C				02	001	04	04	12		.20	999	307	CHECK/TEST			08-2
208	93213	L	44	AA12	.40	C				02	001	04	04	15		.40	999	308	DISASSY			08-2
209	97321	L	BP	Y011	.10	C				02	001	05	05	10		.10	999	309	CLEAN			02-9
210	93213	L	53	AB13	.60	C				02	002	05	05	14		.60	999	310	EXAM			08-2
211	97321	L	BP	Y023	.10	C				02	001	06	06	09		.10	999	311	CLEAN			02-9
212	93215	L	44	AD14	.40	C				02	001	06	06	12		.40	999	312	ASSY			08-2
213	93216	L	53	AE15	.30	C				02	001	06	06	15		.30	999	313	TEST			08-2
214	97321	L	BP	Y035	.10	C				02	001	07	07	10		.10	999	314	FINAL CLEAN			02-9
215	97332	L	BP	Z016	.10	C				02	008	07	08	12		.10	999	315	3FZ			05-2
216	93215	L	XR	AE16	.10	C				02	001	08	08	15		.10	999	316	SELL			08-2
217			EX															317	QV-FINAL-ACCEPT			01-3
218	51220	P	CF							08	000	09	09	15				318				05-2

MISCELLANEOUS INFORMATION GROUP

MDR LOCATION	SPECIAL INSTRUCTIONS

TECHNICAL DATA GROUP

MDR LOCATION	TECHNICAL DIRECTIVES	MDR LOCATION	TECHNICAL DIRECTIVES	MDR LOCATION	TECHNICAL DIRECTIVES	MDR LOCATION	TECHNICAL DIRECTIVES

Figure 3. Master Data Record

accessability from an aircraft or engine or items removed and routed to the finished parts storeroom with no intermediate processing also utilize the RMDR.

The Operational Master Data Record (OMDR) is developed for operations to be performed on the basic aircraft or engine. These operations include disassembly, assembly, work performed on the airframe or engine, painting, flight testing, etc. The Progressing Master Data Record (PMDR) is prepared for each Type/Model of aircraft or engine. The primary purpose of PMDRs is to report status in accordance with locally assigned check points as the units progress through the rework cycle. The Pilot Overhaul MDR is developed for the purpose of establishing production capability for assigned aircraft, engines and components.

2. Data Elements

The data elements contained in the MDR are divided into five major data groups. The data groups are further divided into three types of fields. Key Fields: data fields that are necessary for the record to be of use in subsequent computer processing. The key fields include the MDR Control Code (MDRCC), Component Identity Code (CIN), MDR Location, Change Code and the Shop Category Code. The MDR will be printed on an error listing if these fields are invalid. Optional (uncontrolled) Fields: informational fields which are not critical to the use of the MDR and may be left blank or used as defined.

Mandatory (controlled) Fields: specific purpose fields in which the data is mandatory. If the data are erroneous in either the optional or mandatory fields, it will be overlaid with equal signs and an appropriate error code assigned to the MDR.

The fields within the Control Group control the sequence of MDR placement in the master file and serve as identification data. The Control Group is composed of the following: MDRCC, CIN, source code, error code and change code. The MDRCC identifies the major work program; Family Identification Code (FIC) for the component program; and the schedule frequency and week number for the Recall Calibration and Preventative Maintenance programs. The CIN identifies each routing identity within an MDRCC.

The Part Identification Group contains 24 data fields. These fields contain data for part identification purposes and miscellaneous codes for controlling preparation of operating documents and summarized workload information. The Load and Schedule Group contain data elements required to schedule and control the movement of parts through the process cycle. The Miscellaneous Information Group contains the MDR Location Code and five lines for entering special instructions or any type of information that cannot be entered elsewhere on the MDR. The Technical Data Group has spacing available for listing a maximum of 40 technical directives relating to the routing identity.

B. USE OF MDR

The MDR is an essential part of the documentation system that ensures a timely and orderly flow of work through the NAVAIREWORKFAC. The data elements contained in the MDR are used to prepare Shop Orders, Job Cards and Work-In-Progress (WIP) records which are processed through subsequent computer routines to provide data for planning, scheduling, workload history, cost accounting, operating reports and reports to higher commands. Figure 4 is the typical documentation flow for the Standard Depot Level Maintenance Program for aircraft.

When an aircraft is scheduled for induction to the NAVAIREWORKFAC, the master data file (refer to Figure 3) is inquired by aircraft type and bureau number for all documentation pertainent to that specific aircraft. The computer produces an aircraft file on magnetic tape from the master file that has all the documentation required for rework of that aircraft, and automatically sends documentation to the Examination and Evaluation Branch of the Production Planning and Control Department. When examination and évaluation of the aircraft is completed, the individual aircraft file is inquired for the documentation necessary to direct and monitor the rework cycle on that aircraft.

In addition to reports generated automatically or upon request that provide data to the NAVAIREWORKFAC management, reports are produced that support the MDR master file and reflect the results of MDR maintenance actions.

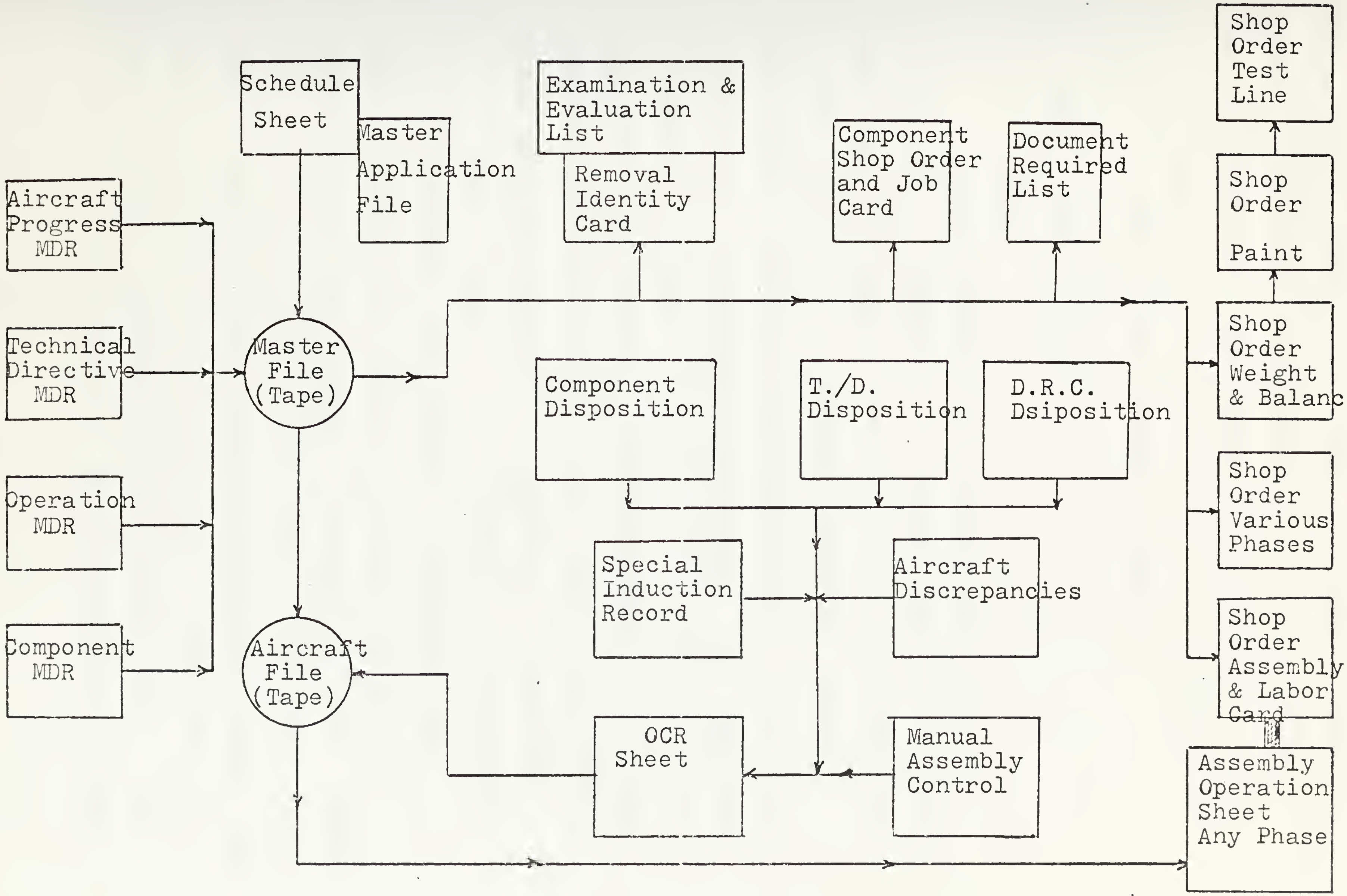


Figure 4. Standard Depot Level Maintenance

These reports tabulate erroneous data submitted and rejected, undesirable conditions within the master file and information extracted from the master file. Table I is a listing of the automatically produced reports that support the MDR file maintenance process.

C. MAINTENANCE OF MDR FILE

1. General

Information retrieval from the MDR master file in the form of managerial reports and workload documentation effects the entire operation of the NAVAIREWORKFAC. The MDR file must be created and maintained properly before any of the other NAILC/MIS Workload Control applications can be successfully operational. The importance of timely and accurate file maintenance cannot be overemphasized. The MDR master file maintenance is a daily routine which involves deletion of obsolete and addition of new MDRs and correction or updating of other MDRs.

The Operations Analysis Division is responsible for the submission and validity of the Master Data Record Worksheet, the Master Data Record Changes and the MDR Control Group Changes and Additions forms. These forms are used to create and maintain the MDR file. The Quality Assurance and Reliability Department, Methods and Standards Division and the Production Planning Division supply required supporting MDR maintenance data to the Operations Analysis Division via the Master Data Record

Title	Prime User	Frequency
MDR Change Card Error List	Code 621	0800 Daily
Master Data Record	Op. Analysis	0800 Daily
MDR Audit and Mgt Ct 1 stats	Op. Analysis	Daily
MDR Deletion Listing	Op. Analysis	0800 Daily
ICP Change Notice Review Listing	Code 620	Weekly
"V" Coded Non-Capability MDRs Report	Code 623	Monthly
Permanent Family File Duplicate IIC Report	Code 523	Monthly
Permanent Family File Deletion Review Listing	Code 523	Monthly
Inventory Control Point PFF Report by Old IIC	Code 523	Monthly
MDR Deletion Review Card	Code 523	Monthly

Table I. Master Data Record Reports Produced Automatically (Ref. 2)

Changes and the MDR Workload Control Form. The Operations Analysis Division is responsible for the physical maintenance of the "hard copy" printed MDRs. These MDRs are available to the Methods and Standards Division, the Quality Assurance Division and any other organizational unit authorized by the Operations Analysis Division. Sample copies of the Master Data Record Worksheet and the Master Data Record Changes Form are shown in Figures 5a and b and 6a and b.

2. New MDR

The creation of a new MDR is initiated by distributing seven numbered computer punch cards, known as the "seven card deck," to organization units within the NAVAIREWORKFAC for the purpose of developing inputs to a new MDR. The Components Branch, OA-621, has control of the process if it is a production MDR; The Pilot Overhaul Branch, OA-623, if it is a pilot MDR. The number six card signals the OA-621 branch to begin research for a new components MDR. An analyst is assigned to the MDR and begins the Master Data Record Worksheet. The worksheet is sent to the various branches for required data inputs and the OA-623 branch establishes the rework capability. When OA-623 has established rework capability and all inputs to the MDR Worksheet have been received by OA-621, the cognizant analyst will forward the worksheet to the OCR typist to be converted to OCR input form and forwarded to DPSCPAC. Figure 7 depicts the

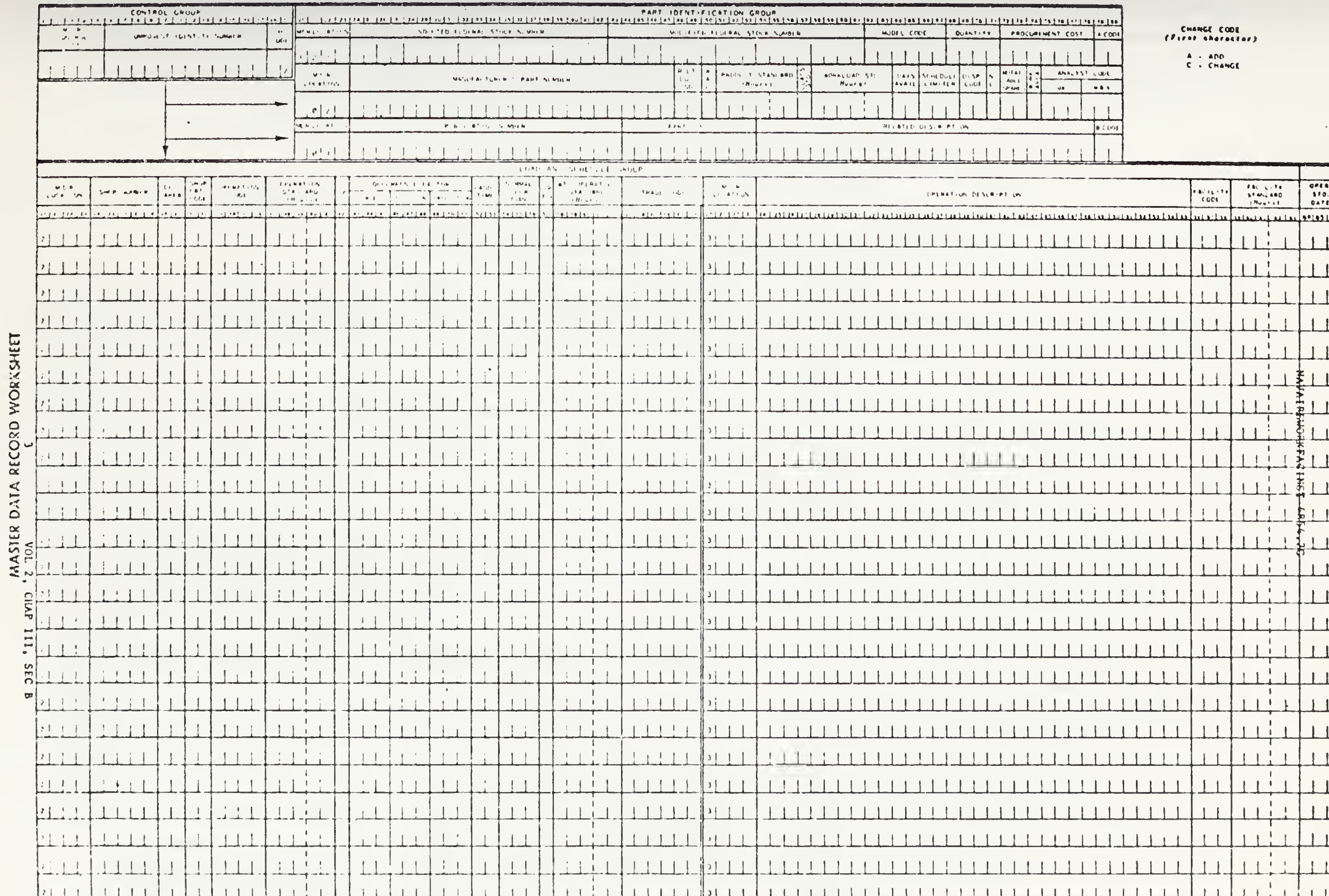


Figure 5a. Master Data Record Worksheet, Front Side

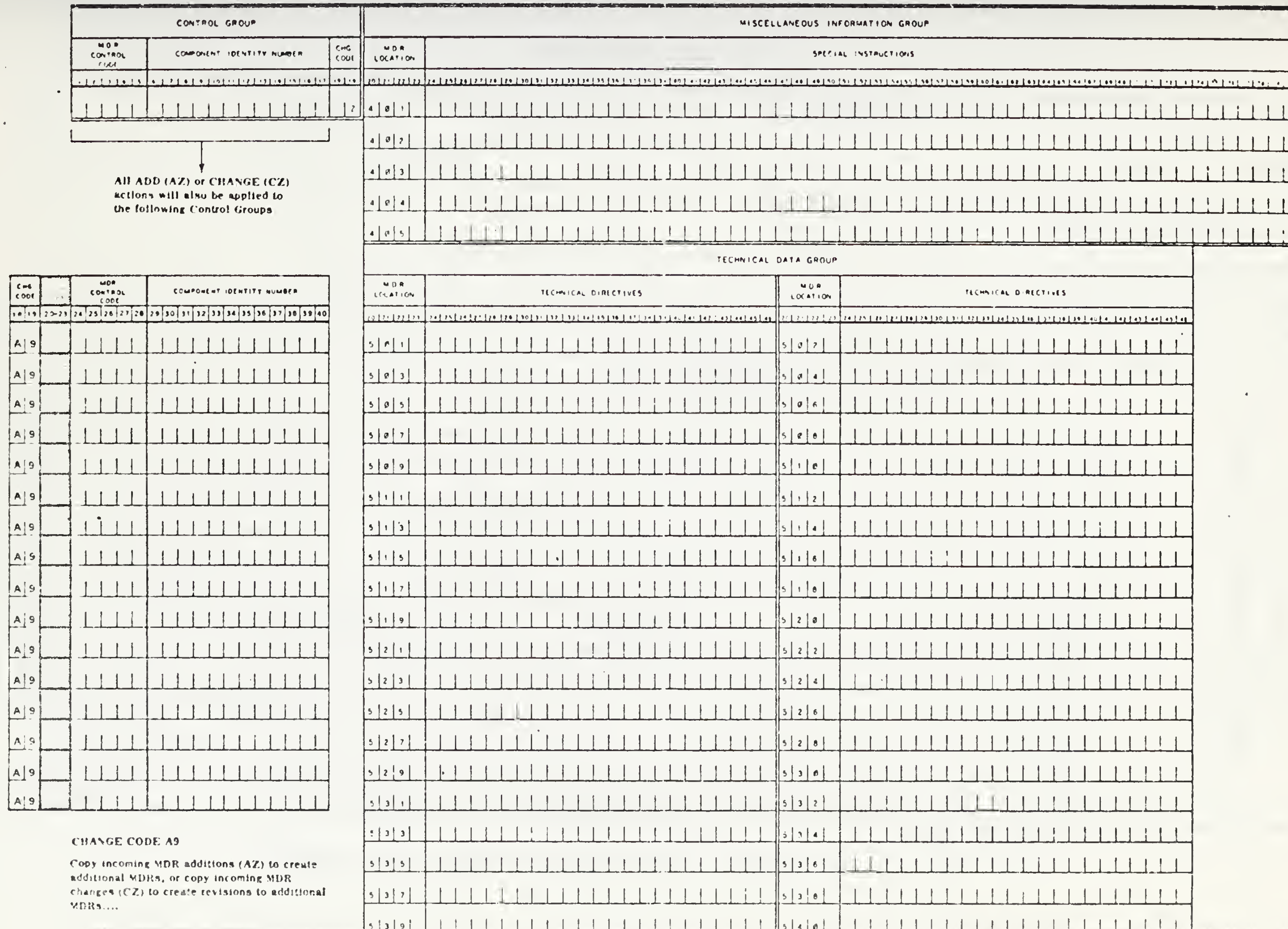
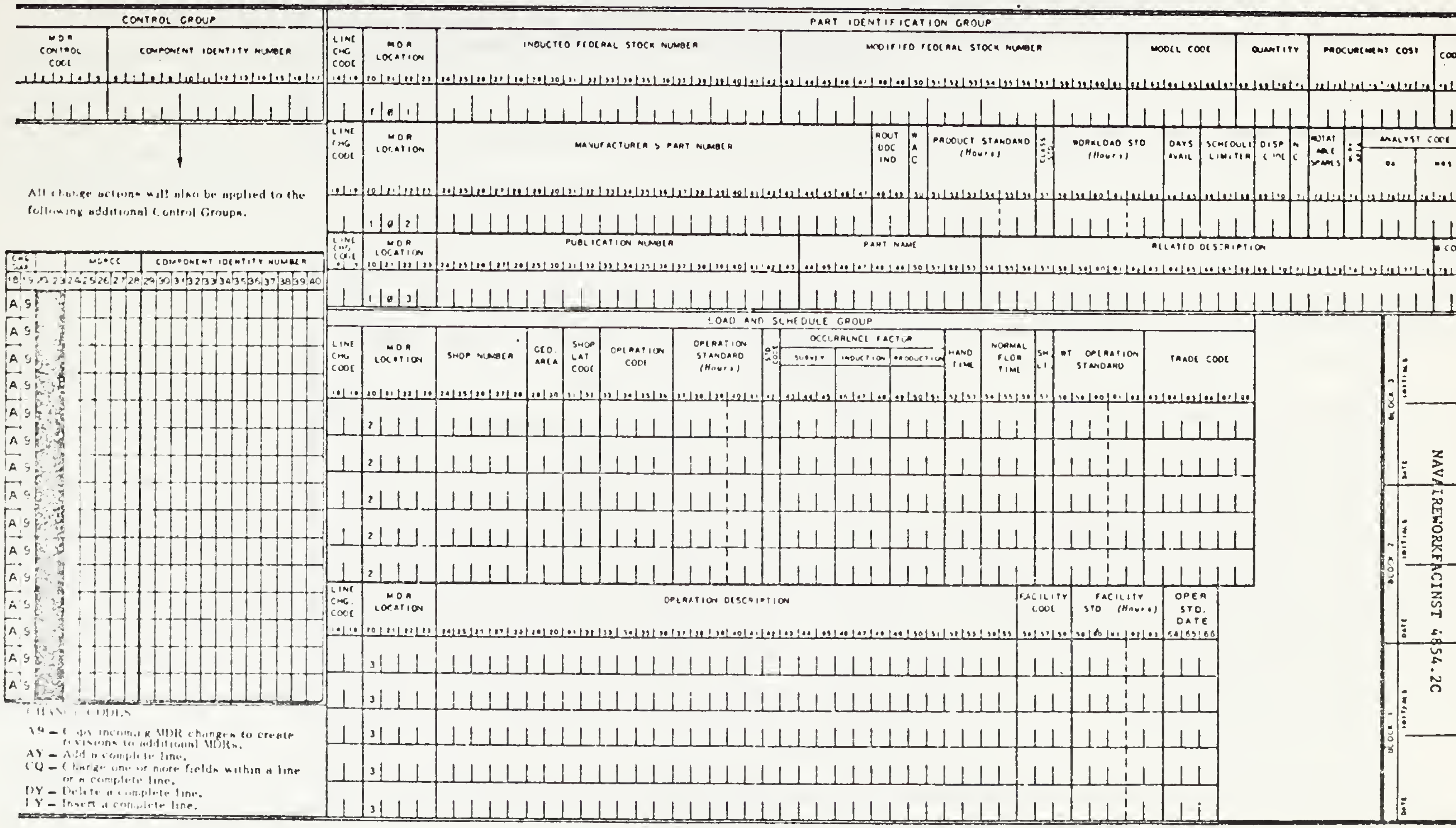


Figure 5b. Master Data Record Worksheet, Back Side

MASTER DATA RECORD CHANGES



CONTROL GROUP

MDR CONTROL CODE | COMPONENT IDENTITY NUMBER

All change actions will also be applied to the following additional Control Groups.

CHG CODE | MDRCC | COMPONENT IDENTITY NUMBER

A9 (repeated on each line)

CHANGE CODES

A9 — Copy incoming MDR changes to create revisions to additional MDRs.
AY — Add a complete line.
CQ — Change one or more fields within a line or a complete line.
DY — Delete a complete line.
IY — Insert a complete line.

PART IDENTIFICATION GROUP

LINE CHG CODE | MDR LOCATION (1 0 1) | INDUCTED FEDERAL STOCK NUMBER | MODIFIED FEDERAL STOCK NUMBER | MODEL CODE | QUANTITY | PROCUREMENT COST | CODE

LINE CHG CODE | MDR LOCATION (1 0 2) | MANUFACTURER'S PART NUMBER | ROUT DOC IND | WAC | PRODUCT STANDARD (Hours) | CLASS | WORKLOAD STD (Hours) | DAYS AVAIL | SCHEDULE LIMITER | DISP CODE | NC | ROTAT ABLE SPARES | ANALYST CODE

LINE CHG CODE | MDR LOCATION (1 0 3) | PUBLICATION NUMBER | PART NAME | RELATED DESCRIPTION | CODE

LOAD AND SCHEDULE GROUP

LINE CHG CODE | MDR LOCATION (2) | SHOP NUMBER | GEO. AREA | SHOP CAT CODE | OPERATION CODE | OPERATION STANDARD (Hours) | OCCURRENCE FACTOR: SURVEY, INDUCTION, PRODUCTION | HAND TIME | NORMAL FLOW TIME | SH LT | WT | OPERATION STANDARD | TRADE CODE

LINE CHG CODE | MDR LOCATION (3) | OPERATION DESCRIPTION | FACILITY CODE | FACILITY STD (Hours) | OPER STD. DATE

NAVAIREWORKFACINST 4854.2C

Figure 6a. Master Data Record Change Form, Front Side

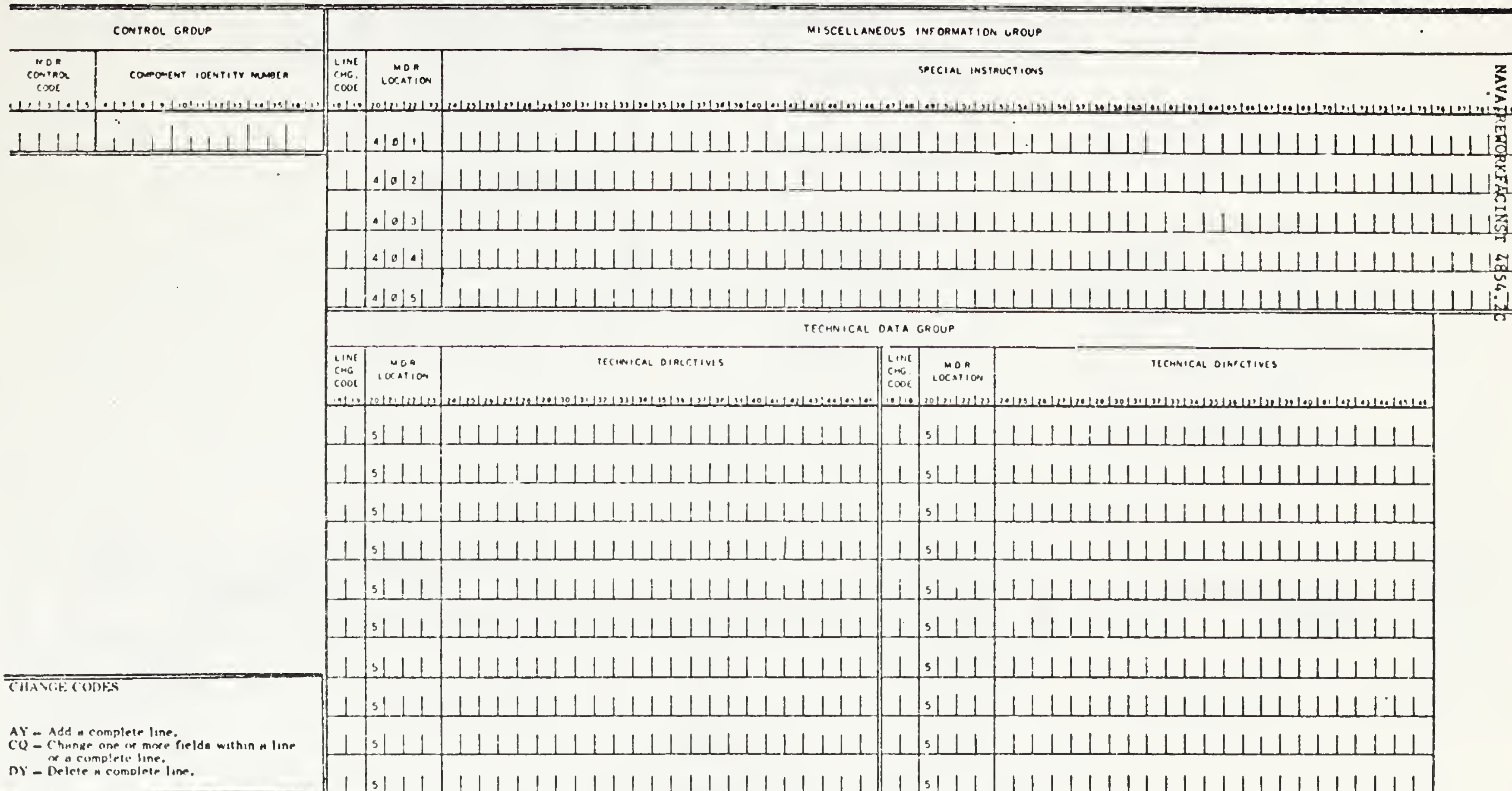


Figure 6b. Master Data Record Change Form, Back Side

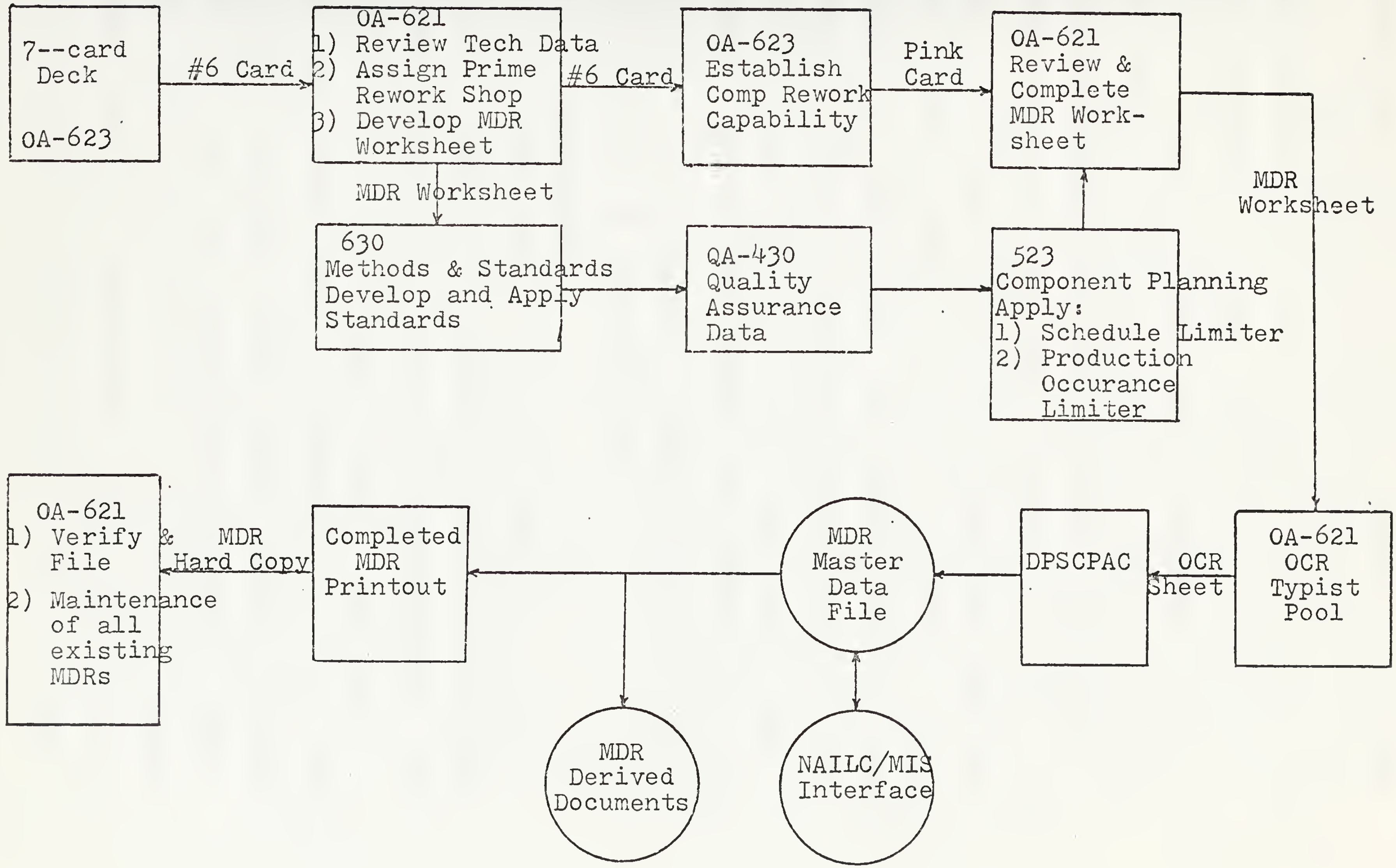


Figure 7. Establishment of Component MDR

documentation flow for the establishment of a new MDR.

The maintenance of the existing MDR file is a daily routine consisting of updating and correcting the data presented on an MDR. Update actions result from changes to time standards, codes, processes, routines and technical directives originating from either within the NAVAIREWORKFAC or outside agencies. The primary change form used is the Master Data Record Changes. The Master Data Record Control Group Changes and Additions form is used to effect changes in the MDRCC and CIN fields in the MDR control group. The preparation of the desired change or update to an MDR is accomplished using manual methods--handwritten forms and the guard mail. The change is input to the computer via an OCR scanner which transfers the information to magnetic tape for later batch updating of the master file.

3. Existing MDR

The MDR change process is initiated in OA-621 with the receipt of a "request for service" from anyone of the organizational units in the NAVAIREWORKFAC. The major inputs to OA-621 come from Quality Assurance Department, 40000, Methods and Standards Division, 63000, Production Planning Division, 52000, Technical Services Division, 35000, and the Production Department, 90000. The "request for service" can be in the form of a memorandum, partially completed MDR change form, MDR change Directive form or verbally by phone. Once the change

request is received by OA-621 an analyst is assigned by the supervisor of the pertinent section within OA-621 which has responsibility for the particular MDR. The analyst retrieves the existing MDR from a storage bin to complete the necessary research and paperwork to effect the requested change. The analyst completes the MDR change form and forwards it to the supervisor of the OCR typist pool.

The MDR change form is checked for completeness and accuracy prior to being assigned to a typist for conversion to the OCR format necessary for computer input. The typed OCR sheet is again checked for accuracy and cleanliness prior to being sent to DPSCPAC for processing. At 1500 each day the OCR sheets completed that day are sent to DPSCPAC to be read by a scanner which stores the data on magnetic tape. At 0400 each morning DPSCPAC runs a batch update of the MDR master file using the data stored on tape from the scanner.

The batching process sequences the MDR change data to create new MDRs and change or delete existing MDRs in the master file. The MDR file maintenance routine edits, validates and reformates the change data to produce a change file for MDR update. An updated MDR file is produced and MDR update reports are generated along with printouts of revised and new MDRs (see Table I).

The OCR sheets are returned to the OCR typists supervisor at 0800 the day following submission along with a diagnostic sheet produced by the OCR scanner which prints out OCR errors by page number and line number on the OCR sheet; a red dot is placed to the left of any OCR line that was incorrect. The OCR typists review and correct any OCR lines that are rejected by the scanner validation routine. The data is retyped and submitted again to the scanner. The printouts of the revised and new MDRs are received by the OCR typists between 0800 and 1400 of the day following submission of the change. The MDRs are compared against the MDR change forms for correctness and then forwarded to the responsible analyst for filing.

Figure 8 depicts the data flow process for an MDR change that originated in the Methods and Standards Division, 63000. Data supporting the time delays involved is given in Appendix A. The physical separation of the Methods and Standards Divisions from OA-621 necessitates hand-carrying, via the guard mail, of all paper work. Some of the MDR changes desired by the Methods and Standards Division require the use of the existing MDR printout, in which case the MDR has to be requested from OA-621. This procedure normally adds one or two days or more to the process of initiating the desired change if requested MDR is unavailable.

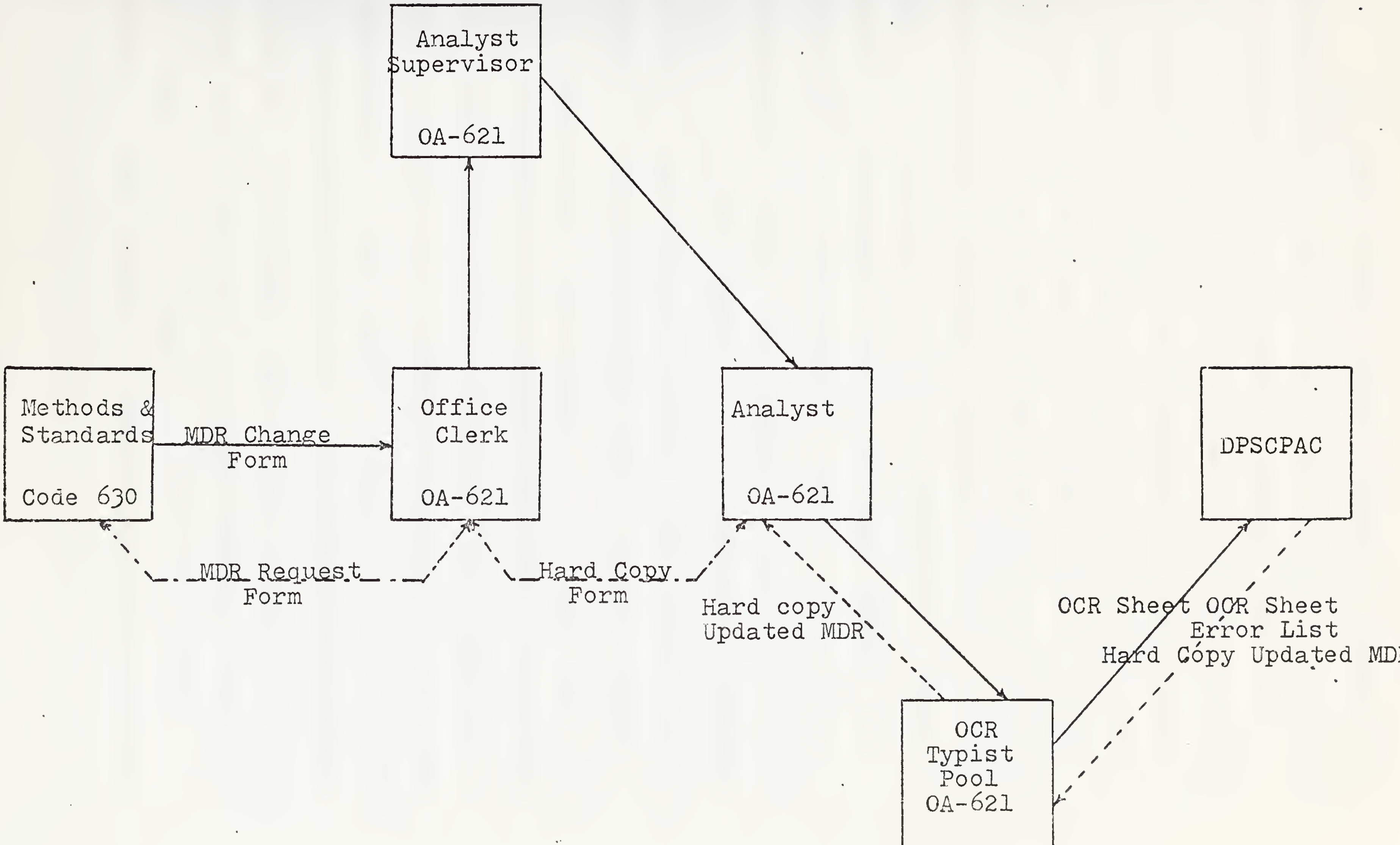


Figure 8. Methods & Standards MDR Update Flow Chart

All component MDR changes desired by Methods and Standards Division have to be routed through OA-621 with the exception of time standards of common operations. These time standards are identified by an Operation Code, MSCC, which is unique to that operation. These changes are forwarded to the Management Methods Division, 21000, where they are converted to OCR format and sent to the DPSCPAC. All other component MDR changes are put on individual MDR change forms and forwarded to OA-621. All MDR changes have to be reviewed by the responsible analyst in OA-621. The analyst checks the change against the existing MDR for proper fields, codes, etc. and enters line number of change. The standard procedure is for the analyst to take this opportunity to review the existing MDR for any other required changes. The analyst then forwards the completed MDR change form to the OCR typists.

The average time involved for the MDR change form to leave the Methods and Standards Division, be processed by the analyst and arrive at the OCR typist supervisor's desk is 1.54 days with a standard deviation of 1.67 days. If one allows one-half day for the guard mail this implies that the MDR change form is in the analyst's possession for one day. The average time the MDR change form is at the OCR typist pool prior to being forwarded to DPSCPAC is 3.08 days with a standard deviation of 1.52 days. Assuming the OCR scanner at DPSCPAC does not reject the data input and adding one day for the MDR master file

update, the time lapse for an MDR to be updated is 5.6 days if no errors are made during the process.

The processing of the MDR change through the OCR typist pool to DPSCPAC and back to the OCR typist pool is as described earlier. The hard copy of the revised MDR is forwarded to the analyst to be filed. However, the Methods and Standards Division does not receive any feedback from OA-621 as to the status of the MDR change. The feedback to the Methods and Standards Division comes through indirect means and at a time weeks after the actual MDR change has been affected. The feedback can be in the form of a computer generated report on MDR file status (see Table I), or a review of the MDR when a second change is necessary. Standard operating procedure is for the Methods and Standards Division to review an MDR for accuracy and completeness each time it comes through the office for one reason or another.

4. MDR Maintenance Workload

The Accessories and Components Branch, OA-621, employs 27 analysts. An analyst is assigned to one of three different sections within OA-621: Aircraft section, F/J section and Process section. One of the analysts assigned to each section is also the supervisor for that section. The branch employs six typists who make up the OCR typist pool, one of the six is also the supervisor. In addition, two secretaries/clerks are employed: one for the Operations Analysis Division and one for OA-621.

The OA-621 MDR file maintenance workload is comprised of updating and deletions of existing MDRs and the creation of new MDRs for aircraft related components. The workload can be further divided into four basic categories: research work for development of new MDRs; research work for update and change of existing MDRs; clerical work-filing, completing MDR change forms, etc; and clerical work for other branch and division MDR inputs for which OA-621 does not have change authority but does have routing authority. The last category is becoming an increasingly greater part of the workload for OA-621 analysts.

Data that was gathered from the records kept by OA-621 personnel is summerized in Table II. The number for revision of existing MDRs includes inputs from other divisions such as Methods and Standards for which OA-621 has routing responsibility. Approximately ten percent of the total MDRs typed were inputs to the OCR typists from the Pilot Overhaul Branch, OA-623. Data gathered through interviews with OA-621 analysts indicate that actual MDR file maintenance comprises approximately 84 percent of their workload (data supporting this number given in Appendix A). The workload is augumented by special projects such as a recent changeover from Federal Stock Numbers to the new National Stock Number system and the projected introduction of the phased maintenance system.

The workload is not evenly distributed between the three sections of OA-621 and varies from day to day

Operation	July	Aug.	Sept.	Total for Qtr.	Total for 1974
New MDRs Written	1249	334	896	2479	12479
Revise Existing MDRs	17673	30829	20790	69292	239622
MDRs from OA-623				5717	28757
MDRs Typed (OCR)	23143	28808	25537	77488	280858
Lines Typed (OCR)	78220	75853	67467	221540	860192

Table II. OA-621 MDR Workload First Qtr FY'75

within each section and within the branch. The uneven nature of the workload necessitates the analyst spending a great deal of time performing clerical duties such as filing when the time could be better spent in research. The overall workload of the OA-621 branch is slowly increasing to the point where the analysts cannot perform their other responsibilities.

The workload of the OCR Typist Pool is divided between converting data from a source document to an OCR format and proofreading of OCR prepared documents against source documents. Proofreading of OCR documents rejected by the OCR scanner is required because of poor alignment of typing on the form, typing across field boundaries, uneven typing, poor spacing, spots on form, etc. In addition, the OCR typist compares the computer printout of the updated MDR against the MDR change form for completeness and accuracy prior to forwarding the MDR to the responsible analyst.

The volume of OCR lines typed daily varies greatly. The time that an MDR form is in the OCR typist pool prior to being typed ranges from one to eight days. Work is backlogged at the OCR typist for several reasons: for example fluctuations in workload and priority system. Table II gives the total number of OCR lines typed by the pool during the first quarter of FY'75 and the entire calendar year, 1974.

III. PROBLEMS AND SOLUTIONS

A. GENERAL

1. Errors

The problem areas encountered in the present manual system of maintaining the MDR file have to be examined from two viewpoints: for example from the viewpoint of the user, the Components Planning Branch, 52300, and from the viewpoint of the MDR producer. The MDR is actually a "basic work plan" for an aircraft or an aircraft related component and its effectiveness cannot be known until long after its contents have been incorporated into firm plans, actions and commitments of the NAVAIREWORKFAC units and rework has begun. Therefore the importance of accuracy and completeness of both the development of new MDRs and the maintenance of existing MDRs cannot be overemphasized. There are three basic types of errors that can occur in the MDR file maintenance process: analyst's errors, typographical errors that are not discovered, and typographical errors that are discovered and corrected prior to being read into the computer.

The analyst deals with two basic concepts: data and information. Data are raw facts in isolation which, when placed in a meaningful context by some process, allow interferences to be drawn. An unlimited amount of data is available from sources both internal and external to

the organization, but not all data produce relevant and timely information. Information is the aggregation or processing of data to provide knowledge or intelligence. The analyst has to gather data through his research and convert the data to some form of useful information. Errors made at this stage either through gathering inaccurate data or using the wrong data to produce erroneous information are not detectable until some later date when the MDR is actually put to use. The ability to detect this type of error is independent of the system, manual or computerized, used to process and store the information and the MDR master file.

The second type of error to be considered is the typographical error (in the case of the MDR maintenance process, an OCR typographical error) that is subsequently discovered and rectified prior to being input to the update tape. The error can be discovered during the proofreading process by the typists or it can be discovered and rejected by the OCR scanner at DPSCPAC. The OCR scanner contains a debug routine which will detect and reject lines of input that are not correctly formatted, contain dirt spots, entries outside the field length, etc. The result on the MDR maintenance process is identical whether the error is detected by the typist or the OCR scanner--increased delay time in the update procedure. A line rejected by the scanner, verified and corrected by the OCR typist, adds at least one day (and usually more) to the time required to update that MDR.

The third type of error is the typographical error that goes undetected and is allowed to pass into the MDR master file. This type of error has the same result as the analyst's error--long term effects. The mistake is not picked up until the MDR is used in some other unit of the NAVAIREWORKFAC; and, then it may be used several times before the mistake is noticed. Once the error is detected, the entire update process is again initiated and the overall result is double the normal amount of time delay and paperwork to get the correct MDR in the master file.

2. Timeliness

The value of information is based on several attributes; of interest here is timeliness and accuracy. Timeliness is related to a shorter elapsed time of the update process input, processing and output to the users for the MDR file. The normal situation is that for information to be timely, the elapsed time from input to output must be reduced. Timeliness is difficult to measure, but its effects can be seen. For example, the Components Planning Branch, 52300, makes inquiries to the MDR master file each weekend; therefore as long as the MDR master file update process has a time delay less than a week, the information is timely for this user. However, for a user, such as the Aircraft Examination and Evaluation Branch, 52600, which may make inquiries daily, a week time delay for changes and corrections to

an MDR is certainly not timely. The MDR master file is presently updated daily, but the frequency of updates does not imply how timely is the information. The important factor is the time delay from input to output within the system.

3. Accuracy

Accuracy pertains to the degree of freedom from error of input and output of the master file. When dealing with large volumes of data and information, two types of mistakes usually occur: errors of transcription and errors of computation. These errors have already been discussed. For the MDR to be of practical use, it must be accurate by the above definition; it must also be comprehensive. Comprehensive refers to the completeness of the information presented on the MDR; it does not mean volume but rather the inclusive aspect of the information. Naturally one desires as accurate a system as possible, but accuracy costs time (as well as money).

The present system has several points where accuracy of the input is checked for accuracy and content. The Operations Analysis' analysts check all inputs for which they have routing responsibility; for example, inputs from the Methods and Standards Division. These inputs are checked for content, correct line number, proper entries to a given field, etc. Once the analyst has completed an MDR change form, it is forwarded to the OCR typists where it is again checked. It is the responsibility of

the OCR typist to call to the attention of the supervisor any random or systematic errors appearing in the source documents. Once typed, the OCR sheet is proofread against the source document prior to being forwarded to the computer center for input to the OCR scanner. The OCR scanner contains a debug routine that checks input data and accepts or rejects data line by line. One mistake in a line rejects the entire line; in some cases an error in a line can also cause the rejection of several succeeding lines. The scanner routine prints out an error sheet listing the rejects by page and line number which is returned to the OCR typists along with the OCR sheets the following morning. The MDR master file batch update routine contains several stages of verification which input data has to go through prior to the file actually being updated. Input data which does not meet the verification process is rejected and the computer prints out an error listing. The error listing is returned to the OCR typists along with printouts of the updated MDRs. The OCR typists verify the updated MDRs by comparison with the source documents prior to forwarding the updated MDRs to the analysts for filing. The present MDR update process contains six levels of error verification, both manual and computerized. The OCR typists spend approximately 50 percent of their time performing the verification function.

The accuracy problem is compounded by the manner in which some branches obtain the MDR derived documents.

MDR derived documents are obtained by submitting document request forms to the computer center. The computer prints out all documents requested once a day. It is the practice of several branches to order more than one set of documents at a time if a need for the documents will arise sometime in the near future. Therefore if the MDR master file is incorrect or in the process of being updated several sets of incorrect documents will be used rather than just one set of incorrect documents.

If the concepts of timeliness and accuracy of data and information and frequency of updating the master file are considered collectively, certain conclusions can be drawn. The time duration between successive updates of the master file has no effect on the timeliness of the information provided the time between updates is shorter than the time elapsed during the update cycle. It is also clear that the more timely information is, then the more relaxed the standards for accuracy of the information can be. Feedback from the output to the input is a necessary element of the cycle. The value of timeliness and accuracy is greatly diminished without feedback.

One theme that was present in most of the interviews conducted at the NAVAIREWORKFAC was a lack of feedback concerning the MDR maintenance process. This was particularly true for the users of the MDR and its derived documents such as the shop order card. Specific examples are the Methods and Standards Branch and the

Aircraft Examination and Evaluation Branch. Some individuals felt that they had no way of knowing what happened to an MDR change request once it had been submitted. In most cases, some sort of feedback system was provided for, but it was used infrequently if at all.

B. EXAMPLES

1. Accessories and Components Branch

The responsibility for file maintenance and storage of approximately 123,000 MDR documents results in a heavy workload being placed on the branch staff and tends to prevent the staff from effectively completing other duties not related to MDR file maintenance. The problem is aggravated by the oscillating nature of the workload both for the branch as a whole and in individual sections of the branch. Additional factors which tend to contribute to the heavy workload are incorrect inputs to OA-621 from other branches and divisions; other branches and divisions making changes and updates to MDRs that are not authorized for that branch; and the human factor--penmanship and handwriting. Unauthorized changes are made to the MDR either by mistake, perhaps due to a lack of understanding of the MDR, and purposely in an attempt to speed things or beat the system.

Some of the problems resulting from the heavy MDR workload are MDR hard copy filing and storage, tedious and repetitive paperwork, a large volume of OCR conversion

(discussed in following section), and huge backlogs of routine changes accumulating due to "one time only" mass changes and priority assignments to change requests. As a result of the oscillating workload, analysts are presently rotated from section to section within the branch to cover backlogs and unexpected increases in the workload. In addition, the analysts assist the OCR typists in their filing and clerical duties and in verification if the typist pool becomes more than four days backlogged. One of the general results of the heavy workload and its accompanying problems is to introduce an appreciable time delay in the MDR update and change process. Interviews with staff members of affected branches establish this time delay to be in a range of three days to a month or more depending on the scope and priority of the change or update. The routine changes are the most likely to be delayed long periods of time as they are backlogged due to the priority system.

The MDR hard copy storage and usage contributes considerably to the overall problem. Only one hard copy of each MDR is produced by the computer and the storage of it is the responsibility of the cognizant branch of the Operations Analysis Division. The single copy is used by all branches of the NAVAIREWORKFAC. This introduces the additional problem of keeping track of the MDR's location when a branch other than the responsible branch has possession of it. (Some aspects of this problem are

discussed in following sections.) The MDR Routing/Control Sheet, Figure 9, initiated by Code 621 (26 September, 1974) represents an attempt to control the MDR document more closely, but also represents additional paperwork. The MDR hard copy documents are stored in moveable tub-type bins at different locations in the components branch, normally in close proximity to the analysts' desk who are concerned with them. Due to the large number of documents, considerable space and time are consumed in storage and filing activities by the staff of the branch.

The Accessories and Components Branch maintains an OCR typist pool consisting of six typists, one of which is the supervisor. These typists handle the input from OA-621, OA-623 and all inputs for which OA-621 has routing and verification responsibility. The present workload is, on the average, within the capabilities of the typist pool. As expected occasional bottlenecks and slack periods do occur; however, the slack periods are disappearing and the workload is steadily increasing.

The purpose of OCR is to decrease the computer input bottleneck by reducing the number of keying operations and errors in transcription. Ideally, the OCR scanner equipment will read any document and transmit the data to the storage tape. However, increased sensitivity to document conditions (such as smudges, creased documents, dirt and poor quality paper) can cause many rejects. The scanner contains a debug routine which will reject

Batch No. ________

Date In	Date Out
	________
________	________
________	________

FROM : Code 621, Building 2

TO: ☐ Quality Assurance
Code ______, Building ______

☐ Methods & Standards
Code 630, Building 94

BATCH DESCRIPTION

	F/E	A/C	PROC	CALIB	
Type:					

Quantity: ________

Originator: ________________

CODE 630 INTERNAL ROUTING

SECTION	ROUTE	DATE OUT	ANALYST	SECTION	ROUTE	DATE OUT	ANALYST
920				960			
930				970			
940				700			
950							

RETURN COMPLETED MDRS TO CODE 630, BUILDING 94

REMARKS:

Figure 9. MDR Routing/Control Sheet

lines of input for certain errors in the input data also. The rejection rate of the OCR Scanner due to the above factors is one percent or less of the submitted data. However, the verification and correction process for this error rate plus the verification time involved in checking the updated MDRs against source documents consumes approximately 50 percent of the OCR typists' daily workload.

There are several contributing factors to the problems encountered in the OCR typist pool. A high turnover rate for the typists due to a lack of advancement opportunities and job oversimplication leads to a low experience level within the typist pool and aggravates the oscillatory nature of the workload. The necessity for absolutely clean OCR documents requires special handling of the OCR sheets. Manual retrieval of source documents to implement corrections and verify errors adds to the clerical filing duties of the OCR typists.

2. Methods and Standards Division

The MDR maintenance that the Methods and Standards Division has responsibility for is the updating and accuracy of time standards on the MDR. About 60 percent of the affected MDR lines fall into an operational coded category and can be changed or updated by a mass change procedure which does not involve the Operational Analysis Division nor does it require Methods and Standards Division to use a copy of the MDR to affect the change.

However, not necessarily 60 percent of the MDR related workload is concerned with this type of change. The remaining portion of the MDR workload may or may not require a copy of the MDR document, but it is required to be routed through either OA-621 or OA-622. If a hard copy of an MDR is required, the document must be requested from the cognizant custodian. If OA-622 has custody of the desired document the time delay is minimal because of the close proximity of Methods and Standards Division to OA-622. If the MDR document is held by OA-621 or OA-622 a request sheet has to be sent either through the guard mail or hand-carried to obtain the specific MDR desired. This method can take as long as three days; if the MDR desired is not available for any reason, such as it being in a current change status or being used by another branch, the delay could be longer. This problem is greatly aggravated by the large number of existing MDRs in the file and the physical separation of the branches requiring the use of the hard copy MDRs.

3. Communications Section, Avionics Division

The feeder shops in the Production Division use the MDR derived shop order card. Each piece of equipment that arrives in a shop is accompanied by a shop order card that lists routing, time standards operational information, etc. The card also contains listings of technical directives and local engineering specifications (LESs). It is important that the shops have accurate and up-to-date

information pertaining to technical directives and LESs. At the present time a shop bench technician checks all incoming components and shop order cards for correct and complete listings of technical directives and LESs pertaining to the specific pieces of equipment. The listings are checked against the technicians knowledge of the equipment and shop maintained files. If incorrect, changes to the existing shop order card or an entirely new shop order card have to be handwritten by the technician. This process is costly both in manhours and paperwork and, in addition, increases the turn-around time of the component in the shop.

The shop supervisor is required to fill out and send a Request for Service form to the Operations Analysis Division when a shop order card is found to be incorrect. Considerable time can be consumed during the MDR change process since analysts and possibly the technical directives branch research the change to insure that it is the correct change required. During this period of time work in the shop is proceeding based on the hand-written changes made by the shop technician which could possibly be found to be incorrect by the analysts.

4. Aircraft Examination and Evaluation Branch

The Aircraft Examination and Evaluation Branch primarily uses the shop order card which is derived from the MDR. Important information provided by the shop order card is shop routing for various components removed

from aircraft undergoing rework and listings of applicable technical directives. Both accuracy and completeness of this information are important. The Aircraft Examination and Evaluation Branch is divided into eight units, each with several people hand tailoring shop order cards either to correct errors or take into consideration special handling of components off a specific aircraft. The large volume of cards and componenets being handled by these units allows the possibility of errors being introduced to the system, as well as errors being discovered and corrected. If inaccurate or, in the case of technical directives, incomplete information is detected, the pre-printed shop order cards provided by the computer are hand edited and used until a correction can be made to the MDR. If the pre-printed documents are completely wrong, a Document Request Card (DCR) is used to request new pre-printed documents. Sometimes as many as three or four aircraft may be affected before the MDR and subsequently the shop order cards are corrected for missing technical directives and LESs. Any error on DCR form entries or errors made by the OCR typist results in the non-receipt of documents and further time delays. The following example from a memorandum dated 4 November, 1974, demonstrates the time delays frequently encountered.

> On 17 October 1974, a DRC Form was initiated to process 22 each assemblies (using Document Request Code "1") on Sequence BX 44, an ACE aircraft. On 22 October 1974, an error sheet was received which showed a wrong job order. Job order "OXT3444" was annotated vice "ØXT3444." (It

may be noted that the Aircraft Program Schedule Sheet #X-50, the Work Jacket for Sequence BX44, and reference (a) are all incorrect in that they show the Aircraft Program as "O" vice "Ø"). On 22 October 1974, the DRC form was resubmitted for the second time. Evidently, the OCR typist dropped the digit "2" in the "day" column. The next error sheet was received on 24 October 1974, by Code 21210, for the third time. On 25 October 1974, we received the cards requested with the exception of two sets of sub-assembly documents. Code 21210 was contacted on 25 October 1974, who in turn initiated a DRC form for those components for the fourth time. As of this data, 4 November 1974, the documentation has not yet been received. Meanwhile, we have initiated HWSD's, handwritten shop orders, for those components and have sent them to their respective feeder shops. (Ref. 3.)

The problem concerning technical directives and LESs in the Aircraft Examination and Evaluation Branch appears to be similar to the problem concerning LESs in the feeder shops in that both situations lead to the necessity of hand-tailored shop order cards. In the case of the LESs at the shop technician level, all of the shop order cards are checked very carefully against shop records and directives and the technician's experience. The value of the shop order card seems to vary with the experience level of the technician. There also appears to be a lack of confidence in the information provided to the technician by the shop order card. During the examination and evaluation phase, the shop order cards are not so carefully checked, and a mistake may go undetected until the component is further into the rework cycle. The important point here is completeness of the technical directive and component routing information provided by the shop order card.

C. ALTERNATIVES

1. General

There are several alternative schemes that can be followed that would alleviate or, hopefully, cure some of the problems besetting the present MDR file maintenance process. The ideal solution is one which would improve the efficiency of the MDR file maintenance process, and at the same time, reduce the costs encountered in MDR file maintenance. Any course of action will require commitment of some level of resources and will produce some level of effectiveness. In choosing an alternative, an organization may take one of two approaches: (1) commit the necessary resources to obtain a specified level of effectiveness; or (2) for a specified level of resources design a system to produce the highest possible level of efficiency. Ideally, there exists some optimum balance between the two approaches; that is, there is some point where further efficiency is insignificant when compared to the added cost. The following list of alternatives is presented in a hierarchy of effectiveness from lowest to highest without regard to cost. Each alternative will be briefly discussed and some advantages and disadvantages will be presented.

2. Additional Manpower

Hiring an additional file clerk or an OCR typist would definitely increase the output of the OCR typists

and reduce the present backlog problem. However, increased OCR capacity does not cure the problem, it merely eases the problem for a time. Adding more analysts to the staff would also reduce backlog and perhaps decrease the MDR update cycle time. Addition of a file clerk would reduce the clerical work performed by analysts at the present time and allow them to give more time to their assigned duties. More personnel increase the training and employee turnover problems while doing little to ease the problems of MDR hard copy storage, high paperwork volume and MDR update cycle time.

3. Modification of MDR Document Storage

The present, centralized storage method for the MDR documents gives rise to three problems: space, filing time and time delays in distributing the documents to users other than the custodians. Each Branch that uses the MDRs could maintain its own file of MDR documents to ease the distribution problem. The major disadvantages of maintaining several separate files is the large size of the files.

Computer Output Microfilm (COM) provides a medium other than paper for storing large amounts of information. The output of the computer is directly to a microfilm recorder which is connected to a film developer. The final output is in either roll film or microfilm form and can be viewed directly through special CRT type readers. Major advantages of COM are: (1.) Microfilm

is rugged and long lasting, it does not require extensive insulation from possible damage from environmental conditions such as radiation, heat and humidity. (2.) The need for storage space is greatly reduced. (3.) It is relatively inexpensive. Disadvantages of COM are: (1.) It is a poor application for large files which require updating. (2.) Requires special microfilm reading devices. (3.) Search and file methods must be performed by hand (Ref. 4).

4. <u>Data Input Systems</u>

The preparation of data for computer processing is a significant bottleneck in any system. In the MDR file maintenance cycle the OCR typist is the interface between the manual portion of the system and the computerized portion of the system and, as such, controls the throughput of the entire system. A punched card system will not be considered because the present OCR system is faster and more efficient. A large portion of the OCR typists' time is consumed in verifying and correcting OCR scanner rejections against source documents. By reducing the volume of data rejection by the computer, the throughput of the system could be greatly increased. Keying data directly onto a storage medium other than the OCR input format would also remove the OCR scanner from the data input process.

The key-to-disk methods involve keying data directly onto magnetic tape or a magnetic disk. A typical

system consists of a low-cost minicomputer; direct access intermediate storage, usually magnetic disk; and magnetic tape for final output. Several keyboards will usually share the centralized minicomputer and storage device. Complex data pooling, formating and entering fixed data fields automatically are possible with this type of system. The keyboard, either CRT or teletypewriter, provides visual verification of the input data being keyed to the storage medium. A debug program, such as the present routine incorporated in the DPSCPAC OCR scanner, could be resident in the minicomputer to detect operator errors and provide immediate error correction. The final output of such a system would be a reel of magnetic tape which could be sent to DPSCPAC to be direct input to the computer for the batch update process.

The advantages of this type of system are:

(1) Elimination of the OCR to magnetic tape conversion.

(2) Input data editing, formatting and verification functions handled automatically by the minicomputer.

(3) Reduction in time lag encountered in error verification in present OCR systems.

The major disadvantages of the key-to-storage method is that the source document still must be manually keyed; only the storage medium has been replaced. Data preparation, speeds and error rates are still dictated by operator efficiency (Ref. 5).

5. <u>On-Line Retrieval</u>

An on-line information retrieval system is one in which a user can directly search a master data file stored in a computer. The system is essentially a one-way communication device between the user and a computer. The input device can be a simple keyboard or a more sophisticated device such as a teletypewriter or CRT display terminal. The input device is tied to the computer via trunk lines or a regular telephone line. In the computer the data base is stored either on magnetic tape or magnetic disk in such a manner that allows the computer to search the data base for requested information. The output device can be either the teletypewriter, CRT terminal or a high speed printer. One high speed printer can handle the output from several input terminals.

The major advantage of an on-line, retrieval-only system to the Operations Analysis Division is the elimination of the MDR printed copy storage and filing requirement. Placing terminals and a printer in each of the divisions who have a requirement for printed MDRs would also reduce the problem encountered in the present centralized MDR storage system. The decrease in the amount of time spent in filing activities would allow the analyst to spend more time at his primary duties.

Major disadvantages of the system are: (1) OCR typists still required to enter data into the system; and, hence, the system would not reduce the error rate or time

delay attributable to the OCR typists, and (2) the amount of paperwork is not diminished.

6. On-Line Retrieval and Update

The system required for on-line retrieval and update is composed of the same basic equipment as a system for retrieval only. However, the system is now a two-way communication device between the user and the computer. The system operates in a time-sharing mode which gives the user the illusion that he is the sole user of the computer when, in reality, the computer is being shared among a number of independent activities and users. The system can be either a real-time or delayed-time system. A real-time retrieval system responds so rapidly to a query that its response may be regarded as immediate or quick enough to be utilized in the continuation of the task being conducted. The update process can also operate in either a real-time or delayed-time mode. In a real-time operation, the master file is continuously updated as an analyst communicates with the computer via a terminal. In delayed-time operation, update instructions and data are input to the computer via the terminal and stored on magnetic tape or a magnetic disk temporary storage medium. At some later time, the accumulated data is batch processed and the MDR master file is updated in the same fashion as the present system.

The major advantages of this system compared with the present MDR maintenance system are:

(1) Elimination of the OCR typists and the OCR format to magnetic tape conversion process.

(2) Elimination of the MDR printed copy storage and filing requirement.

(3) Immediate feedback to the analysts concerning input data errors.

(4) Reduction in the amount of paperwork required of the analysts.

(5) A reduction in the elapsed time for an MDR to be updated.

Disadvantages associated with the on-line file maintenance systems are of two types: those associated with the introduction of the system and those of a continuing nature. The major problem encountered during introduction of the system is the change-over from the old to the new system. The analysts have to be trained to operate the terminals or new personnel have to be acquired as operators. Disadvantages of a continuing nature are:

(1) File security.

(2) System downtime.

(3) One or two OCR typists have to be retained to handle unexpected workload or to handle workload during extended downtime of the computer.

(4) Source documents still must be keyed into the computer.

(5) Practically everyone understands the present system.

7. New System

Three alternatives always exist when a system and a set of user requirements are evaluated: (1) to do nothing, (2) to modify an existing system and (3) to design a new system. The alternatives discussed previously modify the existing system in an attempt to more effectively satisfy the MDR file maintenance requirements. The final alternative available is to design a new system; this last alternative is obviously the most complex and difficult solution to implement. The present MDR file maintenance system is interfaced with the NAILC/MIS system and any redesign of the present MDR maintenance systems would affect the entire NAILC/MIS system. However, the present MDR may not be adaptable to any of the alternatives discussed above. The most cost-effective solution may be to completely redesign the MDR and at the same time design a computerized file maintenance system.

IV. NAVAIREWORKFAC ON-LINE PROJECT

A. GENERAL

The ON-LINE PROJECT at NAVAIREWORKFAC was initiated in 1973 with the primary purpose being to eliminate the delay and uncertainty of batch process update of the MDR master file. The final form of the proposed system, Figure 10, is to use a randomly accessed master file and real-time update to give immediate validation of updates and changes and a continuously current MDR file. An auxillary purpose was to affect cost savings, time savings and space savings by eliminating most of the bulky, manually maintained desk files. The project began with a rather ambitious and optimistic time schedule which was immediately beset with money and people restraints and, perhaps, somewhat of a lack of interest on the part of the management. At the present time, the implementation date for the full system has slipped by at least a year with the full system operation date currently set for February, 1976. It is hoped to have a prototype system installed and operating in OA-621 by the end of November, 1975.

Work on the project has proceeded in three areas: (1) Design of several formats to display portions of the MDR on a CRT. (2) Development of the specifications and procedures that define how the user and DPSCPAC

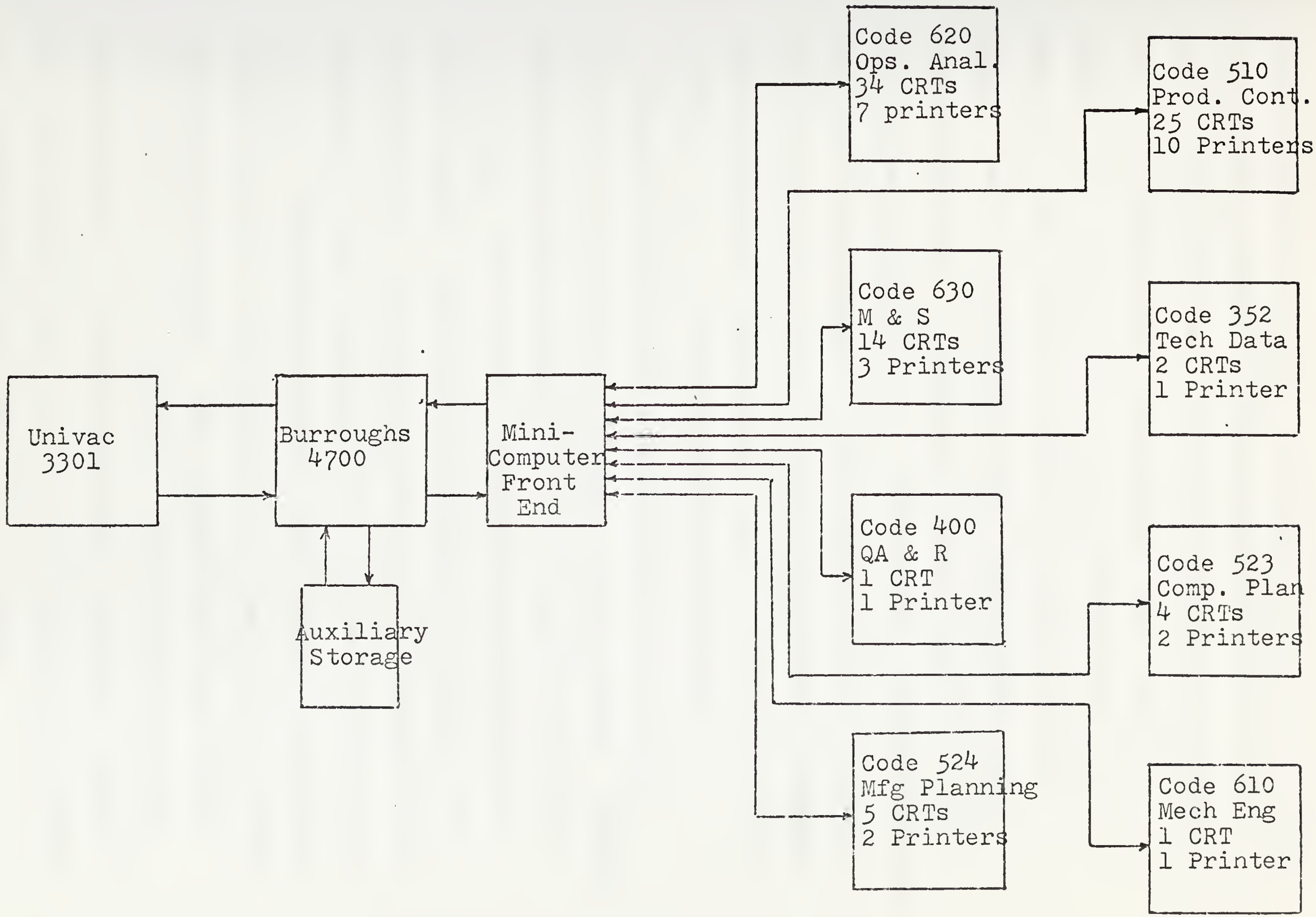


Figure 10. Proposed NAVAIREWORKFAC On-Line System

interact with the system. (3) Specifications to develop the software necessary to process the data and perform the MDR file maintenance function (completed on 15 March 1975). (4) System user requirements were compiled (Appendix B). In addition, the project personnel have made field trips to the U.S. Army Tank and Automotive Command, Warren, Michigan and Rohr Data Systems, Chula Vista, California to familiarize themselves with on-line file maintenance and communication systems. Several vendors have also been contacted to gain information on equipment required for such a system. User requirements, management specifications and system specifications will be forwarded to DPSCPAC who will write the software programs.

Planning conferences between DPSCPAC and Code 210 personnel have produced a proposed on-line system. DPSCPAC computer facilities consist of two Univac 3301 systems, one Burroughs 4500 and one Burroughs 4700 system plus several smaller computers and peripheral equipment. The proposed system, Figure 10, would use the Burroughs 4700 computer plus additional equipment that would have to be acquired: communication lines, CRT terminals, auxiliary storage units and a minicomputer front-end processor for the Burroughs Computer. The proposed prototype system is consisted of five terminals, four in OA-621 and one at DPSCPAC plus an off-line printer in OA-621. The proposed CRT terminal has capability of displaying 11 lines that are maximum of 80 characters in length.

The present MDR master file contains 159,000 records, with a maximum length of 4100 characters. The file is a part of the NAILC/MIS system, on magnetic tape, and run on a Univac 3301 computer system. The format of the file is not readily convertable to random access type storage required for a true on-line system. One of the major problems is that the MDR master file is interfaced with the rest of the NAILC/MIS programs and therefore an MDR file is required in the NAILC/MIS system. The present proposal is to duplicate the MDR file on magnetic tape each day and load it into the Burroughs 4700 for operation of the on-line file maintenance.

To meet the user requirements, the MDR master file data base has to be altered in one or more of three ways: (1) in the format of the file, (2) the content of the file, (3)in the storage medium where the file is located. Two logical file organization techniques are used for data storage and on-line systems. In a sequental file, records are physically arranged on the storage media in the same order as their logical sequence. File maintenance and search operations are particularly inefficient in this type of file. Files can be organized by grouping together all records which have some common value used as an index term; this is called a subfile. An inverted file is created by establishing a collection of subfiles consisting of all the file partitions that are generated by grouping records that have some field value in common. This

organization requires a dictionary or directory containing all the data values in the system and the locations where those values occur. The major advantage of an inverted file is random access capability; however both the file and the directory have to be maintained. An inverted or indexed sequential file is proposed for the on-line project. This type of file organization provides the advantages of inverted files without the disadvantages.

B. EQUIPMENT

In order to operate an on-line system effectively the user need not even know of the existence of system components other than the terminal he is using and, perhaps, an off-line printer. The system is composed of several components: the central processing unit (CPU) auxiliary storage, communication unit peripheral devices and some type of communications medium to link the units together. The following paragraphs will briefly describe the components of the on-line system (Ref. 4).

The heart of any computer system or configuration is the CPU; all computer configurations perform five basic functions: (1) input, (2) primary storage, (3) arithmetic-logic, (4) controls, (5) output. The actual CPU is made up of the primary storage, arithmetic-logic and control functions. The input function makes available to the CPU the data to be processed and instructions as to the method of processing. The output refers to the results of the data processed within the CPU and is written on

any one or a combination of various output media. The input and output units also translate the data into machine language from whatever form it is provided in and vice versa.

The computer system requires controls to perform the following functions:

(1) Tell the input device what data to enter into primary storage and when and where to enter it.

(2) Tell the arithmetic-logic section what operations to perform, where the data is and where to place the results.

(3) Tell what file devices to access and what data to access, and

(4) Tell what output media the results are written on. The arithmetic-logic section manipulates tha data in accordance with the algorithm of instructions. The manipulations are performed one operation at a time, with intermediat results being placed in primary storage. The primary storage is that section of the CPU where data and instructions are entered from the input device; results of intermediate processing of data are stored here along with final results until the computer is directed to write the results on output media.

The stated size of the CPU refers to the capacity of the primary storage. The size of a processor's primary storage helps to determine the maximum size of programs and the maximum amount of data available for processing at any one time. Storage capacity is expressed in terms

of the number of addressable storage locations within the primary storage unit. The byte, made up of eight binary digits and a parity digit, is the basic storage unit of some computer systems. These bytes can be strung together in different ways to provide variable-length or fixed-length words. Flexibility results from the ability to string together bytes to make half-words, words and double words. The Burroughs 4700 computer system has a primary storage of 500 K (where K means thousands); that is, it has 500,000 storage locations (bytes) each of which is addressable by a programmer.

The CPU can also be evaluated by two other aspects: access time and cycle time. Access time refers to the time it takes for the control section to locate instructions and data for processing. The CPU operates on pulses per length of time like a clock. During the instruction cycle, an instruction is obtained from a primary storage location and transferred to the arithmetic-logic section. During the execution cycle the instruction is executed using date in locations specified by the instruction; then the computer shifts back to the instruction cycle. The cost of pirmary storage is based on speed; as speed increases, the cost per bit stored increases. The virtual storage technique is a scheme which appears to increase the size of the primary storage. The basic idea is the dynamic linking of the primary storage with a slower, larger auxiliary storage.

Magnetic disks are the most popular choice among computer vendors and users. Magnetic disks come in several sizes and models; some are stationary devices and others are in the form of a stack of rotating metal discs on a spindle. Each disk surface is divided into tracks which are analogous to flattened, circular sections of magnetic tape. Read-write heads mounted on access arms move in and out of the stack and are positioned over a particular track which contains data of interest. The speed with which data are written or read is dependent upon access mechanism movement time, type of read-write head, rotation speed of disk pack and the density at which the data are recorded. The transfer rate of a typical disk pack is 156,000 bytes per second. Disk files may be organized sequentially and processed like magnetic tape in addition to indexed sequential and direct access organization. On-line inquiry capability of large files is an example of the flexibility of disks.

When the total number of terminals and printers and the amount of data transmitted exceed a certain level, the computer control progran (in residence) can no longer execute the interrupts, move the data into and out of storage and perform the necessary housekeeping without significant reduction in computer throughput. To increase the capacity of the computer system, these functions can be moved out of the CPU and into a communications processor of "frontend" processor. Channels from various

terminals and other remote devices end at the front-end processor, and this processor in turn transmits clean data to the host CPU. A front-end processor will perform some, if not all, of the following functions:

(1) Act as a message-switching center, acts as the central exchange in a fully interconnected communications network between terminals.

(2) Routine housekeeping duties such as data requests, handling of message queries and priorities, etc.

(3) Error checking and verification.

(4) Gathering of system statistics.

(5) Code translation into the machine language of the host CPU.

(6) Preprocessing and editing.

(7) Routing messages to and from required memory locations and notifying the software as required.

Devices which are used to get the data into the system and information from the systems are called terminals. Terminals vary from teletypewriters to card readers, high-speed printers, CRTs, etc. An intelligent terminal, with the aid of a minicomputer, has the capability to perform operations on the data it handles in addition to transmitting it to the CPU. Minicomputers are physically small, relatively inexpensive and have a stored program of at least 4K. Minicomputers are used as front-ends (as discussed in the preceding paragraph), general

purpose computer systems and as intelligent terminals. Rather than use a front-end to the CPU in a computer system, intellignet terminals can be sued to extend the capacity of the CPU. Also it is feasible for the terminal to accept transactions and perform some processing when the main computer is down or the communications system is interrupted.

CRT terminals are available in an almost countless variety of capabilities and prices. Basically, a CRT terminal has a keyboard for alphameric data entry and a CRT for visual output. The primary internal components are a memory and a character generator. The memory allows the operator to transmit data by the page or screenful rather than character by character. Most CRT terminals have optional data entry and editing devices available such as a cursor--a spot or other symbol on the face of the CRT that indicates the location at which the next data entry or reception operation will take place; or a light pen--an electronic ballpoint pen that emits a stream of electrons and is used to write directly on the CRT screen.

C. IMPLEMENTATION OF THE ON-LINE SYSTEM

The proposed implementation schedule for the MDR on-line project calls for a moduler or pilot approach. Initial installation of prototype equipment and training of personnel is to begin in September, 1975. The prototype

is to be installed in OA-621 and the MDR file for a particular aircraft program will be run in parallel with the manual system for a period of 30 days. There are several advantages to this type of approach. A high degree of protection is provided in the event of failure of the system. The risk of system failure is localized and the problems can be identified and corrected before further implementation is attempted. This approach also provides a live, hands-on environment to train operating personnel.

The implementation scheme is modular in that the system is to be introduced in levels of complexity. On-line retrieval of MDR records only will be the first level. As the on-line retrieval becomes operational and perfected, on-line, batch updating of the prototype file will begin. The final stage of implementation real-time update and retrieval of the entire MDR master file. The phase-in approach offers several advantages: (1) rate of change can be minimized, (2) the system can be implemented over long time period with a minimum budget, (3) equipment can be acquired over a longer time period-reduced initial capital outlay. A major disadvantage is the development of a demoralizing atmosphere in the organization of "never completing a system" (Ref. 4).

V. DISCUSSION AND RECOMMENDATIONS

A. ON-LINE PROJECT

1. General

The on-line project being pursued at the NAVAIRE-WORKFAC is essentially a conversion from one method of data processing to another method of data processing. The project is not an attempt to alter the design of the system but to computerize a specific activity of the system--MDR master file maintenance. Several problems have surfaced during the development of the project: the large size of the MDR master file, the size and complexity of an individual MDR and the need to interface the MDR master file with the remainder of the NAILC/MIS system.

The development cycle of a management information system needs to contain control systems, well identified check points and organization checks and balances in order to make efficient use of resources. This cycle is broken up into separate phases, the phases serving as structural standards, which guide the system development. Table III is a suggested breakdown of the development process into six phases.

The development schedule for the NAVAIREWORKFAC On-Line Project, Appendix C, does not include a feasibility study. The feasibility study allows management to

Phase	Title
I	Feasibility Study
II	System Specification
III	System Engineering
IV	Programming and Procedure Development
V	Implementations
VI	Operation

Table III. System Development Cycle (Ref. 6)

answer questions in three areas: (1) Is the proposed system a solution to the actual problem? (2) Does sufficient economic justification exist to allocate resources to the project? (3) How does the project fit into the master plan? System projects should be within the context of the organization's long-range master that defines the general nature of systems that will be developed for some extended time period. Each project must be evaluated against that master plan, and either modified to be consistent with it or cause changes to the master plan.

2. <u>User Requirements</u>

The user requirements (Appendix B) were compiled during interviews and conferences between project personnel and users. Several iterations of the process were necessary to get the list of requirements to its present form which agrees well with a suggested list of user requirements for a general on-line system. To

completely satisfy the user requirements would neccessitate implementation of a full on-line retrieval and real-time update system. To effectively implement such a system would require extensive redesign of the present MDR file maintenance process, the MDR master file and the concept of the MDR itself. This task is beyond the scope of the NAVAIREWORKFAC.

3. <u>Proposed System</u>

The proposed on-line system utilizes CRT type terminals with a maximum line length of 80 characters. The maximum line length of an MDR record requires a line length of 120 characters. In addition only 11 lines can be displayed on the CRT at any one time. These restrictions have necessitated extensive redesign of the format of the MDR record into eight separate displays. This reflects a decision made during the beginning stages of the project based on the fact a CRT of large enough capacity was not then currently available and that the hardware for the system was intended to be purchased outright. At the present time, CRTs of large enough capacity are available but at a cost greater than twice the smaller version. The original intention to buy has since been modified to the idea of leasing.

The proposed system uses 17 CRT Terminals, 16 for the analysts and one for display purposes. Calculations made using the workload data collected, Table II and Appendix A, show that a minimum of 15 CRT terminals will

be required to handle the full workload of OA-621. The data also show that only four terminals would be sufficient for a record retrieval only system. The time required to complete an MDR update operation was based on estimates of individual analysts to complete an update operation in the present, manual system. This time figure assumed no learning curve for the analysts once the on-line system was fully implemented. The time required for a file search and retrieval operation was assumed constant at one and a half minutes per operation. The sample size taken was relatively small and therefore the data is not as good as it could be. Comparing the analysts' estimates with OA-621 branch records indicate workload and time estimates may be underestimated.

One problem that has not yet been considered to any extent by project personnel is that of file security. In any information system incorporating a large data base, security is an important aspect. One example of a file security system taken from a court information system incorporates four levels: (1) Each person authorized to update the files is assigned an access code. (2) Certain terminals are designated as display terminals only. (3) Transactions on given terminals are restricted to certain files only based on areas of responsibility. (4) Transactions for a given terminal are restricted to authorized fields and modifications to the file can only be made during those periods when authorized persons are on duty (Ref. 4).

B. RECOMMENDATIONS

1. Cost Evaluation of On-Line Project

The on-line project is an investment of resources and as such should be justified in terms of a cost-effectiveness analysis. Questions that should be answered are: (1) assumed operational lifetime of system; (2) project development cost; (3) present system operating cost; (4) projected operating cost of new system; and (5) operating cost benefits. Certain costs of the system are sunk costs, for example procurement costs of equipment, and can be amortized over the lifetime of the system. Other costs, such as maintenance and operational costs or lease payments, are recurring costs and, as such, effect the monthly cash flow of the organization. When comparing the costs of new systems against present systems, care should be taken to insure that the marginal costs are given the proper attention.

A preliminary MDR system cost comparison was performed by the on-line project personnel during February, 1975. The estimated cost savings for the first year of full operation of the on-line system were approximately $170,000. However, included in this estimate were sunk costs of equipment, such as storage bins and OCR typewriters, already owned by the NAVAIREWORKFAC which makes the estimate arrived at highly questionable.

2. Lease or Buy

If a system is going to be in operation for more than about five years it is generally cheaper to buy rather than lease. However, leasing does not require as large an initial outlay and does offer the advantage of greater flexibility in the choices of equipment. For the application being pursued by the NAVAIREWORKFAC, it is recommended that leasing be considered for the CRT terminals.

3. "Brand Y"

The U.S. Navy is proposing to upgrade the DPSCPAC computer facilities with the acquisition of a new computer system commonly referred to as "Brand Y." The proposed implementation date is currently July, 1976. The proposed date for full implementation of the NAVAIREWORKFAC On-line system is February-March, 1976. It should be ensured that any equipment acquired, any software acquired and/or any system modifications made are compatible with "Brand Y." Further, enough flexibility in the on-line sustem must be retained to take advantage of whatever the new computer can offer.

4. Study of MDR system

The present motivation for the MDR on-line project is to produce a "better product." That is, to produce an MDR file that is as accurate and up to date as possible. A study must be made of the MDR and the role it plays in overall operation of the NAVAIREWORKFAC to look for

justification and benefits of the on-line project, or of a completely redesigned system, in terms of overall performance of the organization. The question to be asked is: What can be done to the MDR system to produce a more efficient and timely rework cycle for the aircraft for which NAVAIREWORKFAC has responsibility?

APPENDIX A. DATA

I. TIME DATA

Table IV gives the data collected on the elapsed time required for MDR change forms to travel from the Methods and Standards Division, 63000, to the OCR typist pool in OA-621; and the amount of time required in the OCR typist pool for MDR change form to be converted to OCR format for input to the computer. The elapsed time includes only working days. The data was taken from the Methods and Standards input to OA-621 during the period from 20 January 1975 to 7 February 1975.

Elapsed Time (Days)	# of MDR Change forms from 630 to 621	# of MDR Change forms in 621 OCR pool
0	105	0
1	78	46
2	40	93
3	51	27
4	19	92
5	1	32
6	1	4
7	8	0
8	2	8
9	0	0
10	0	0

Table IV. MDR Flow Time

the mean (630 to OCR) = $\overline{X}$ = 1.54 days

the variation = s^2 = 2.81; the standard deviation = s=1.67 days

If a normal distribution holds:

95% confident of not exceeding 4.9 days

99% confident of not exceeding 6.4 days

The mean (time in OCR pool) = $\overline{X}$ = 3.08 days

The variation = s = 2.42

The standard deviation = s=1.56 days

If the normal distributions holds:

95% confident of not exceeding 6.2 days

99% confident of not exceeding 7.8 days

Type Operation	Analysts' Estimates ave.	low	high	$\overline{X}$
	% of Workload			
A	43	20	67	43
B	31	13	55	32
C	12	6	19	14
	Time for Operation (minutes)			
A	2.1	.6	2.6	2
B	7.3	4	11	7.3
C	12.6	8	22	13.4

Operations Type

A: 1 to 2 line MDR change
B: 5 lines or greater (1 MDR change form)
C: new MDR

Table V. MDR Workload and Time Estimates

The data in Table V is reduced data gathered during interviews with Operations Analysis analysts employed in OA-621. The analysts estimated what percentage of their workload was made up of the different type MDR operations. The estimates for time required for the operations does not include research time. The analysts estimated that 84 percent (mean) of their total work load was comprised

of MDR file maintenance operations. The sample size was 12 percent of the analysts employed by OA-621.

The data in Tables II and V can be used to make a rough calculation of the minimum number of terminals required in the system. The calculations refer to the OA-621 Branch only.

A = number of MDR records updated per hour

S = number of update operations per hour that is within the capacity of one terminal

C = minimum number of terminals

t = time required for operation

$t = (.48)\ (2) + (.36)\ (7.3) + (.16)\ (13.4) = 5.7$ minutes

$S = 60/5.7 \approx 10.5$ operations per hour

$$\frac{A}{CS} < 1 \Rightarrow C > \frac{A}{S} = 14.42 \Rightarrow C \geq 15$$

For retrieval only, assume retrieval operation takes 1.5 minutes maximum:

$S = 60/1.5 = 40$ operations per hour

$\frac{A}{CS} < 1 \Rightarrow C \geq 4$ terminals

APPENDIX B: ON-LINE USER REQUIREMENTS

A. GENERAL REQUIREMENTS

1. Convert the magnetic tape MDR file to a random access storage medium.

2. Provide real-time (response to inquiry within 5 to 10 seconds with 30 seconds maximum) access and update of the file.

3. Control access to records and changes to certain parts of records by requiring authorization codes (vertical and horizontal).

4. Maintain cross-references on-line, either as dictionary type files or extracts from the MDRs. When an MDR is updated, automatically update the applicable report and/or cross reference files.

5. Provide for local option programs. Those required at North Island include a Manufacturing Program adaption of the MDR file, a Quality Characteristics List file, and a Pilot Overhaul program.

6. Output the file on magnetic tape daily to interface with other standard applications. This output can also become backup for the random access file. The daily file dump and a tape with the daily transactions will be needed for recovery.

7. Acquire CRT and printing terminals which will handle the record in its present format and will allow "rolling" forward and backward to display a complete MDR.

8. Provide special function keys for add, delete, etc.

9. Reduce record size by reducing unused records. (i.e. Non-used 4XX and 5XX lines.) Publish a maximum file size based on hardware limits.

10. Reduce file size by implementing a multi-use MDR.

11. Provide on-line, real-time access during working hours of the prime shift with exceptions as required.

12. After 3 minutes of display in an update made with no action, clear the CRT but retain the display in memory to allow a recall with a function key.

B. INQUIRY REQUIREMENTS

1. Special function keys to bring up option programs (display, print, edit, etc.) should be labeled as such on the keyboard. A key to generate four zeros (beginning with either position 1, 5, or 9 of the CIN) would facilitate input of CINs.

2. Accept proper inquiries by Part Number, Operations Analyst Code, Operation Code, NIIN, and other specified MDR fields. Display and print as required the MDRCC and CIN of applicable records (or print off line where volume prohibits on-line reports). Display an MDR shown in any X-Ref display by moving cursor to proper MDRCC/CIN and pushing one function key. If only one MDRCC/CIN is applicable, display it. Retain batch process report programs.

3. Accept inquiries to display either or:

   a. An MDR (MDRCC and CIN)

   b. An MDR and its subordinates
   (NOTE: Indicate that there are subordinate or parent MDRs.)

   c. An MDR and its overflows
   (NOTE: Indicate that there are overflow MDRs.)

4. Accept request for display by next responsible code for double certification by M&S, Ops Analysis or Q.A.

5. Accept requests on-line for preparation of off-line overnight reports.

C. DISPLAY REQUIREMENTS

1. Retrieve and display an entire record or as much as practical, in its present format, on a CRT screen with the capability to print it on a remote printer as required.
(NOTE: Several 80 column formats are enclosed if request is not feasible.)

2. Upon authorized and valid inquiry from a terminal by entry of an MDRCC and CIN:

   a. Display the record on a CRT (or multiple terminals simultaneously, if called), <u>or</u>

   b. Print the record on the printer, <u>or</u>

c. Indicate on either device that there is no such record on file.

3. Print a record at an addressed terminal other than the one where the transaction originates, upon authority and proper command.

4. Display or print reports on-line. Cross references were mentioned previously. In addition, report deleted records to cognizant Operations Analysts. Report deleted lines to M&S. Report records in the "holding" status to originator after a specified period of time. Print changes in alpha negative codes, non-capability records, for Code 623, and deletion of such records to 354, 523, 612, and 620 only. Generate and print kitting lists for manufacturing jobs (part of a local option). Print QCLs upon proper request from control center terminals (another option).

5. Upon receipt of proper authorization, display assignments of security codes and statistics such as records on file, numbers of changes by terminal, etc.

6. Space filled 4XX and 5XX lines need not be displayed.

7. Retain the last record displayed to allow recall with a minimum of input.

8. Allow retrieval of an MDR and its subordinates or overflows. Provide for "rolling" MDRs forward or backward by means of a single function key vice a keying of a new control group.

D. UPDATE REQUIREMENTS

1. Allow editing of a displayed record on a CRT, via keyboard input with new data displayed as typed.

2. Duplicate all the input validations now employed in the batch method, but apply them On-Line. Indicate errors to the user of the CRT terminal, and do not accept invalid input.

3. Enable editing of a record displayed on the CRT, when authority and validity is established. Allow one terminal at a time, in a change mode, to locate a line, and any character within a line. Write input characters over the old record, storing such input until a command is given to effect the change. At that time, write the new record to the file and display it to the user. Accept new records in the same way.

4. Delete entire MDRs, upon proper authority. Write deleted records to a history tape, to be retained for one year.

5. Require multiple authority on certain changes. Chain a trailer record of a proposed change until the proper authorization is applied. While this "holding" record is on the file, indicate its presence to terminals which access the parent record. Display or print either the parent or the "holding" record upon proper command. Accept change input to the "holding" record. Upon receipt of necessary authorizations, replace the parent with the changed record and display it.

6. Perform mass copy action changes to as many records as possible. These changes include those in the present system and some new requirements. These changes may be validated on-line and updated off-line overnight.

7. Place all changes requiring more than one organizational entities input into a "holdup" file until all change requirements are met.

8. Indicate on each line, the time date and source of last line change.

9. Automatically "spread" a field if a character or characters are inserted. Indicate as an error if the fields spreads to exceed the space allotment.

APPENDIX C. ON-LINE PROJECT TENTATIVE PLAN

I. Designate Representatives from each area

II. Work out "real world" details with each representative.

III. Compile and evaluate needs in terms of input, output, and hardware.

IV. Get approval of statement of requirements by NARF people involved.

V. Confer with DPSCPAC.

VI. Prepare problem difinition document and submit it to DPSCPAC. Submit any separate hardware requirements to appropriate agency.

VII. Prepare programs and hardware.

VIII. Test and evaluate system

IX. Prepare operating procedures

X. Conduct training.

XI. Implement.

TABLE VI. Initial On-Line Project Schedule (Ref. 8)

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